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SIXTEENTH ANNUAL REPORT

OF THE

ILLINOIS SOCIETY

OF

Engineers and Surveyors

BEING THE

PROCEEDINGS OF THE SOCIETY

AT ITS

Sixteenth Annual Meeting

HELD AT

BLOOMINGTON, ILL., January 23, 24, 25, 1901.

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OFFICERS AND COMMITTEES.

OFFICERS, 1901.

Henry G. Paddock, *President.*
Emil Rudolph, *Vice-President.*
A. L. Kuehn, *Executive Secretary and Treasurer.*
D. W. Mead, P. C. Knight, A. D. Thompson,
J. G. Melluish, *Trustees.*

COMMITTEES.

Surveying:
W. A. Hay, *Chairman;* Emil Rudolph, L. Z. Jones.

Roads and Pavements:
I. O. Baker, *Chairman;* W. H. Tarrant, C. H. Nicolet.

Railroads:
E. E. R. Tratman, *Chairman;* M. S. Ketchum, L. P. Atwood.

Water Works:
W. D. Mead, *Chairman;* D. E. Huggins, W. S. Shields.

Drainage:
P. C. Knight, *Chairman;* John Zeter, A. H. Bell.

Sewers:
J. W. Alvord, *Chairman;* Geo. W. Chandler, H. E. Beasley.

Exhibit:
H. A. Stevens, *Chairman;* Rudolph Link, C. S. McLane.

Press:
A. L. Kuehn, *Chairman;* E. E. R. Tratman, C. C. Brown.

SPECIAL COMMITTEES.

Paving Brick, Specifications and Tests:
A. N. Talbot, *Chairman;* C. V. Seastone, D. V. Purington.

Architecture:
S. A. Bullard, *Chairman;* N. Clifford Ricker, Fridolin Oswald.

Mechanical Engineering:
E. E. Johnson, *Chairman;* L. C. Quade, D. H. Maury, Jr.

Electrical Engineering:
L. E. Fischer, *Chairman;* A. C. Loomis, J. G. Melluish.

Surveyors' License Legislation:
H. G. Paddock, *Chairman;* Samuel S. Greeley, W. H. Tarrant.

LIST OF MEMBERS

OF THE

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.

1901.

Abell, W. W., Civil Engineer, Elgin
Alvord, John W., Civil Engineer, 127 Hartford Building, Chicago
Anderson, C. G., Civil Engineer, 24 Arcade Building, Peoria
Ashley, Burton J., Chief Engineer Zion City, 1201 Mich. Boul. Chicago
Atwood, L. P., Engr. M. of W., R. G. S. M. & P. Ry., Box 708, El Paso, Texas

Baker, I. O., Professor Civil Engineering, University of Illinois, Campaign
Beasley, Harry E., Civil Engineer, 712 Niagara Building, Peoria
Bell, A. H., Civil Engineer and County Surveyor, Bloomington
Blanding, M. J., City Engineer, Galesburg
Bremer, H. H., Surveyor, 100 Washington St., Chicago
Brown, Geo. A., Civil Engineer, Bloomington
Brown, Geo. W., Civil Engineer, Joliet
Bullard, Samuel A., Architect and Sanitary Engineer, 208 Sixth Street, Springfield
Burnham, J. H., Agent King Bridge Co., 418 Eddy Building, Bloomington

Carberry, Ray S., Civil Engr. Engineer's Office, O.S.L.R.R., Pocatello, Idaho
Chandler, Geo. W., City Engineer, Canton
Chase, Chas. P., City Engr. and Mgr. Iowa Engineering Co., Clinton, Ia
Chipman, Paul, Civil Engineer, Mt. Carmel
Clark, G. M., Drainage Engineer, Woodford County, Low Point
Clark, J. L., Surveyor and Civil Engineer, Momence
Connolly, Frank M., Assistant City Engineer, Galesburg
Cornell, W. H., Draftsman Ft. Pitt Bridge Co., Canonsburg, Pa.
Cottingham, Chas., Civil Engineer, 405 Kimbrough-Platt Building Danville
Crowley, John, Supt. for Flick-Johnson Construction Co., Davenport, Iowa

Darling, W. A., Civil Engineer, Rock Island
Day, Wm. J., County Surveyor, Bement

Dolph, Orson, Surveyor,	Yorkville
Doty, Duane, Civil Engneer,	Pullman
Dubuis, O. F., Landscape Engineer,	Peoria
Dunn, Chas. H., Civil Engineer and County Surveyor,	Peoria

Elliott, C. G., Engineer Henry Oil Co.,	Sistersville, W. Va.
Ellsworth, Chas. E., County Surveyor,	Danville
Enos, Allen, Civil Engineer,	Springfield
Enos, Z. A., Civil Engineer,	Springfield
Ericson, John, City Engineer,	City Hall, Chicago
Evans, Wallace C., Civil Engineer and Contractor,	100 Y.M.C.A.bdg.,Peoria

Feeney, William P., Surveyor,	461 Washington Boul., Chicago
Fischer, Louis E.,	Danville
Folsom, Elmer, City Engineer,	Bloomington

Gastman, G. W., Surveyor,	Hudson
Gates, A. W., Civil Engineer Monmouth Mng. & Mfg. Co.,	Monmouth
Gerber, Winfred Dean, Civil Engnieer,	Rockford
Goodenough, Geo. A., Assistant Professor of Mechanical Engineering,	University of Illinois, Urbana
Gordon, Daniel, Civil Engineer and Surveyor,	Moline
Graham, Geo. W., City Engineer,	Freeport
Grantz, Conrad, Street Commissioner,	Moline
Graves, Edward A., Civil Engineer,	Streator
Greeley, Frederick, Surveyor	822 Opera House Block, Chicago

Harman, Jacob A., Civil Engineer,	Peoria
Hay, W. H., Civil Engineer,	Sandwich
Herron, W. H., Topographer, U. S. Geological Survey,	Washington, D. C.
Holbrook, Watson C., Civil Engineer and Surveyor,	Sterling
Howard, S. N., Surveyor and Sec'y Greely Howard Co.,	822 Opera House Block, Chicago
Holmes, C., County Surveyor,	Macomb
Huggins, D. E., Superintendent of Water Works,	Streator
Huston, R. C., Surveyor,	Room 1, County Bldg., Chicago

Jansen, D. H., City Engineer,	Pekin
Johnson, Edward E., Mechanical Engineer,	First Nat'l Bank Bldg., Chicago
Jaffray, J. R., County Surveyor,	Belvidere
Jones, Lloyd Z., Surveyor,	Galva

Knight, Philip C., Drainage Engineer and Surveyor, Pontiac
Ketchum, M. S., Assistant Professor of Civil Engineering,
University of Illinois, Champaign
Kuehn, A. L., Instructor in Civil Engineering, University of Illinois, Urbana

Lemen, W. C., City Engineer, Paris
Loomis, Arthur C., City Engineer, Mattoon
Link, Rudolph, Mngr. Keuffel & Esser Co., 111 Madison St., Chicago

Maury, Dabney H., Jr., Consulting Engineer and Engr. Peoria
Water Works Company, Peoria
Mead, D. W., Civil Engineer, 605 First National Bank Building, Chicago
Melluish, James G., Civil and Sanitary Engineer, Bloomington
Miller, S. W., Manager Pacific Flush Tank Co., 84 LaSalle Street, Chicago
Miller, J. Ed., City Engineer and County Surveor, Monmouth
Monserrat, N. D., Hocking Valley R'y Co., Columbus, O.
McAuley, John B., Civil Engineer, Galesburg
McClanahan, T. S., Surveyor and Civil Engineer, Monmouth
McLane, Cyrus D., Assistant Professor of Architecture,
University of Illinois, Urbana
McNabb, John M., Surveyor and Drainage Engineer, Mt. Palatine

Nicolet, Chas. H., Enginneer with M. & H. Zinc Co., LaSalle
Norlin, Fred, Surveyor, 711 Opera House Block, Chicago

Orr, Robert E., Engineer E. J. & E. Ry., Joliet
Orwig, H. I., Land Dept. C. & N. W. Ry., Chicago
Oswald, Fridolin, Architect and County Surveyor, Alhambra

Paddock, Henry G., City Engineer, Moline
Parmley, Walter C., Civil Engineer, 18 Burt Street, Cleveland, Ohio
Parr, James F., Assistant City Engineer, East St. Louis
Purington, D. V., 2141 Calumet Ave., Chicago

Quade, John C., Engineer with Western Tube Works, Kewaunee

Ricker, N. Clifford, Prof. of Architecture, University of Illinois, Urbana
Rosencrans, Wm. H., Civil Engineer, South Bend, Ind.
Rudolph, Emil, Surveyor, 408 Opera House Block, Chicago

Schmeltzer, J. Foster, Surveyor, Manteno
Seastone, Chas. V., Instructor in Civil Engineering,
Purdue University, La Fayette, Ind.
Serviss, John H., Civil Engineer, Closter, N. J.

Sexton, Chester H., Engineer,	Beardstown
Shepardson, John Eaton, City Engineer,	Kewanee
Sherman, Leroy K., Asst. Engineer, Sanitary Dist., Chicago,	452 W. Congress St., Chicago
Shields, W. S., Civil Engineer and Surveyor,	127 Hartford Bldg., Chicago
Sims, Lewis J., Drainage Engineer,	Lincoln
Slocum, Roy H., Assistant in Applied Mechanics,	University of Ill., Urbana
Smith, Owen T., Engineer and Superintendent Water Co.,	Freeport
Snow, T. W., Civil Engineer,	Batavia
Stevens, Hubert A., City Engineer,	Joliet
Stewart, John T., Civil Engineer, (U. S. Geological Survey)	Paxton
Stowell, Chas. C., Civil Engineer,	Rockford
Talbot, A. N., Professor of Municipal and Sanitary Engineering,	University of Illinois, Urbana
Tarrant, Wm. H., City Engineer,	Champaign
Thompson, A. D.,	Commercial Club Bldg., Indianapolis, Ind.
Tratman, E. E. **Russell**, Associate Editor "*Engineering News*,"	1336 Monadnock Block, Chicago
Treichler, Wallace, Civil Engineer,	Rock Island
Vial, Robert C., Asst. Engineer, C. & W. I. R. R.,	LaGrange
Whitaker, E. H., Drainage Engineer,	LaSalle
Withington, J., Surveyor,	Mattoon
Wrightman, Geo. F., Civil Engineer,	Lacon
Zeter, John, County Surveyor,	Lincoln

HONORARY MEMBERS.

Frost, Geo. H.,	New York, N. Y.
Greeley, Samuel S.	Chicago
Hodgman, F.,	Climax, Mich.

ANNOUNCEMENT

THE SEVENTEENTH ANNUAL MEETING of the Illinois Society of Engineers and Surveyors will be held at Joliet, Illinois, January 22, 23 and 24, 1902. An interesting program will be arranged and it is hoped that all members will attend.

Chairmen of Committees should arrange at once with members of their committees and others for papers for the annual meeting.

Members will assist the Society by patronizing the firms whose advertisements appear in this Report.

PROCEEDINGS

OF THE

SIXTEENTH ANNUAL MEETING

OF THE

Illinois Society of Engineers and Surveyors

HELD AT

BLOOMINGTON, ILL., JANUARY, 23, 24 and 25, 1901.

JANUARY 23, 1901. AFTERNOON SESSION.

The meeting was called to order at 2:30 o'clock in the council chamber of the city hall of Bloomington, President Charles Carroll Brown presiding. There were 36 members present.

An address of welcome was made by the Hon. Lewis B. Thomas, Mayor of Bloomington. It was responded to by Vice-President Henry G. Paddock.

The President delivered the annual address.

The topic "What Legislation is Needed to Secure Legal Reports From All Drainage Districts" was discussed by Messrs. J. H. Burnham, P. C. Knight, W. A. Hay, and the President.

A paper entitled "Open Watercourse Drains for Land Drainage" by P. C. Knight was read by the author. It was discussed by the President and Prof. A. N. Talbot.

A paper by W. H. Herron entitled "Proposed Topographic Map for Illinois" was read by the author. It was discussed by Messrs. P. C. Knight, W. A. Hay, and H. G. Paddock, and Profs. A. N. Talbot and M. S. Ketchum.

On motion of Prof. A. N. Talbot the matter was referred to a committee of three to report at the session of January 24. The President appointed Messrs. W. H. Herron, and W. A. Hay, and Prof. I. O. Baker.

Upon recommendation of Prof. I. O. Baker, Mr. S. S. Greeley was elected an honorary member of the Society.

On recommendation of Mr. J. H. Burnham, a committee of three was appointed to nominate officers of the Society.

The topic "Advantages and Values of Fillers for Brick Pavements" was discussed by Messrs. W. H. Tarrant, H. G. Paddock, H. E. Beasley, and Profs. I. O. Baker and A. N. Talbot.

Adjourned until 8 o'clock P. M.

JANUARY 23, 1901. EVENING SESSION.

The report of the Committee on Roads and Pavements was read by W. H. Tarrant, chairman of the Committee. Report was discussed by Mr. J. H. Burnham.

A paper entitled "Cost of Wagon Transportation" by I. O. Baker was read by the author.

The President introduced Mr. H. H. Gross of the Road Inquiry Office of the Department of Agriculture and gave him the privilege of the floor.

The paper was discussed by Messrs. S. A. Bullard, J. H. Burnham, H. H. Gross, Prof. M. S. Ketchum, and the President.

A paper entitled "Expenditures for Earth Roads" by I. O. Baker was read by the author. Following this was a general discussion on the question of country roads. This included the topics "What Improvements are Practical in Road Administration," "What can be done to Improve Common Earth Roads," and "Is Legislation Needed in Illinois Permitting State Aid for Hard Roads?" The discussion was made by Messrs. J. H. Burnham, P. C. Knight, H. H. Gross, E. E. R. Tratman, and Profs. I. O. Baker and M. S. Ketchum.

A paper entitled "Hard Roads of McLean County" by A. H. Bell was read by the author. It was discussed by Messrs. H. H. Gross, J. A. Harman, J. G. Melluish, and Prof. I. O. Baker.

JANUARY 24, 1901. MORNING SESSION.

A paper by W. H. Tarrant entitled "Modern Brick Pavements" was read by the author.

The report of the Committee on Sanitary Legislation was presented by D. W. Mead, chairman of the Committee. It was as follows:

To the Members of the Illinois Society of Engineers and Surveyors:

GENTLEMEN: The legislature has not been in session the last year and the Committee has done nothing with the question of sanitary legislation. It is suggested that the Committee be given the opportunity for presenting a bill similar to that previously presented. A new Committee might be appointed to formulate the views of the Society for action at this session of the legislature. It is further suggested that it would not be well to present too much at this session of the legislature, but the new Committee would carry out the ideas of the Society in this regard.

D. W. MEAD,
L. E. FISCHER,
J. H. BURNHAM,
Committee.

The Committee on Geological Survey, which was appointed at the afternoon session of January 23, made the following report:

To the Members of the Illinois Society of Engineers and Surveyors:

GENTLEMEN: It is proposed that the State of Illinois co-operate with the U. S. Geological Survey in making a topographic map of the State under the following plan: that the U. S. Geological Survey will expend an amount equal to that of Illinois.

The money furnished by the State and also about sixty per cent. of the federal appropriation to be expended for the subsistence of field parties and for services of temporary employes, residents of the State.

The U. S. Geological Survey is now co-operating on this basis with Maine, New York, Pennsylvania, Maryland, Alabama and Ohio.

A topographic map would be of great value to the engineer:

1st. To enable him to easily determine the exact location of water sheds for drainage purposes and water supply.

2nd. In the investigation of questions relating to water power.

3rd. In planning drainage systems.

4th. In the economic location of public highways, electric railroads, etc.

5th. In representing the natural undulations of the surface as showing the quality and value of the land.

6th. In studying the question of water pollution and filtration.

7th. And in the study of any problem which is influenced by surface configuration.

Where such maps exist they are in constant use, not only by engineers, but by all classes of citizens.

Co-operation with the U. S. Geological Survey would be of importance to the State, not only as to the amount of money appropriated by the United States, but also in saving the large expenditure necessary in training a corps of topographic engineers, and in saving the money required to equip and maintain an engraving and printing establishment, and also the cost of administration of the whole survey.

Therefore we recommend that the Illinois Society of Engineers and Surveyors petition the present State legislature to make an appropriation of $20,000 per annum for the above purpose.

And we further recommend that the individual members use their personal efforts to secure the enactment of such legislation.

We also recommend that the Society secure copies of the paper recently presented to this Society by Wm. H. Herron, for the use of members in this connection.

We further recommend that the Secretary be directed to have printed copies of this resolution for the members of this Society.

I. O. BAKER,
W. A. HAY,
WM. H. HERRON,
Committee.

The report was discussed by Mr. J. W. Alvord.

The report of the Committee on Architecture was read by S. A. Bullard, chairman of the Committee.

Upon recommendation of Prof. I. O. Baker, Mr. George H. Frost was elected an honorary member of the Society.

A proposed bill for the licensing of land surveyors was presented by H. G. Paddock. He moved that the bill be referred to a committee of five to report at some future time during the meeting.

The motion was carried and the President appointed Messrs. J. G. Melluish, S. S. Greeley, H. G. Paddock, and W. A. Hay, and Prof. A. N. Talbot.

The following resolution was read by J. A. Harman:

WHEREAS, The permanent improvement of the main public highways is demanded by the highest social, educational, and economic reasons, and

WHEREAS, Such highway improvement would be of great and lasting benefit to all the people and be an important factor in the highest and best development of citizenship,

***Resolved*, That it is the sense of this Society that the following would be a wise precedent. The State should assume and pay from general taxation a fair and equitable proportion of the cost of any permanent improvement placed upon the highways of the State of Illinois, provided that an acceptable plan be devised for distributing the cost between the State, the County, the Township and the contiguous property benefited. Be it further**

***Resolved*, That it is the sense of this Society that the initiative for any permanent improvement shall rest with the people of the locality in which the improvement is to be made and that the maintenance of the roads shall be carefully provided for.**

The resolution was adopted.

It was moved by Mr. D. W. Mead that all the matters of special legislation be referred to a committee of five.

The motion was carried and the President appointed Messrs. D. W. Mead, J. W. Alvord, J. L. Clark, J. H. Burnham and P. C. Knight.

The report of the Committee on Paving Brick Specifications was read by A. N. Talbot, chairman of the Committee. It was discussed by Messrs. D. W. Mead, J. A. Harman, H. H. Gross, and J. H. Burnham. A part of the report was adopted, the remainder was referred back to the Committee for further consideration.

The topic "In Adopting Old Corners Not Made by the Government Surveyors, What is the Maximum Allowance to be Made for Errors in Alinement and Bearing," was discussed by Messrs. J. L. Clark and H. G. Paddock and Prof. M. S. Ketchum.

A paper entitled "Results of the License Law for Architects in Illinois" by N. C. Ricker was read by the author. It was discussed by Mr. Fridolin Oswald.

Adjourned until 8 o'clock P. M.

JANUARY 24, 1901. EXCURSION.

At 1 o'clock P. M. the members of the Society started on a trip of inspection in special cars provided by the Bloomington & Normal Electric Ry. Co. The city water and electric light plant, the Chicago & Alton Co.'s shops, and the Central Heating Plant were visited.

JANUARY 24, 1901. EVENING SESSION.

The Committee on Nominations made the following recommendations: For President, H. G. Paddock, for Vice-President, Emil Rudolph, for Trustees, P. C. Knight and J. H. Melluish. The Committee also recommended that Joliet be chosen as the place for the next meeting.

The members nominated were elected by ballot. On motion it was decided that the next meeting be held at Joliet.

A paper entitled "The Effect of Curvature on the Strength of Machine Parts" was read by title.

The report of the Committee on Railroads was read by E. E. R. Tratman, chairman of the Committee.

A paper entitled "Proposed Street Railway Subway System for Chicago" by W. H. Rosencrans was read by Mr. E. E. R. Tratman, who also discussed it.

The Secretary announced that Mr. Jerome Plankington, Member of the Society, had died, and asked that a committee be appointed to draft resolutions.

The President appointed Messrs. Emil Rudolph, and E. E. R. Tratman and Prof. M. S. Ketchum.

A paper entitled "Some Experiences in Designing a City" by Burton J. Ashley was read by the author. It was discussed by Messrs. J. H. Burnham, A. L. Kuehn, and J. W. Alvord, and Prof. M. S. Ketchum.

The Committee on a Bill for the Licensing of Land Surveyors which was appointed at the morning session of this day, made the following report:

To the Members of the Illinois Society of Engineers and Surveyors:

GENTLEMEN: The Committee to whom was referred the matter of the proposed Bill for the Licensing of Land Surveyors presents the following bill for the consideration of the Society:

SECTION I.

ARTICLE 1. Be it enacted by the people of Illinois, represented in the General Assembly: That the Governor of this State shall nominate, and with the consent of the Senate, shall appoint, one member of the faculty of the University of Illinois and four Land Surveyors, who shall have been practicing as such continuously in the State during the past ten years, who together shall be known as the Illinois Surveyors' Examining Board.

ART. 2. The Examiners shall hold office respectively for one, two, three, four and five years as the Governor shall appoint, from the last Monday in January next after the passage of this Act, and until tneir successors shall be appointed and qualified. They shall be, *ipso facto*, Illinois Land Surveyors, and may as a Board issue licenses to themselves individually as such, as hereinafter provided for issuing licenses to candidates.

ART. 3. Before the last Monday of January in each year thereafter the Governor shall nominate and, with the consent of the Senate, appoint a successor to the member whose term of office is to expire that year. One Examiner shall be a member of the said faculty, and the other four shall be Illinois Land Surveyors holding licenses under this Act. Examiners so appointed shall hold office for five years, and until their successors are qualified. They shall take and subscribe the Constitutional oath or affirmation of office.

ART. 4. Whenever any Examiner shall fail habitually to perform the duties of his office, the Governor may, at the request of a majority of the other Examiners, and on due evidence, declare the office of such Examiner vacant, and shall appoint his successor. All vacancies from any cause shall be filled by appointment of the Governor, approved by the Senate, for the remainder of the term.

ART. 5. The Board shall elect one of their number as President, and shall elect one person, who may be a member of the Board, as Secretary and Treasurer. They shall adopt rules of procedure. They shall meet each year once in the Capital of the State and once in Chicago, and as often as may be found necessary at some railroad centre convenient of access. At any meeting except executive sessions the Board shall examine all candidates, who shall present themselves.

ART. 6. The Secretary, before entering on the duties of his office, shall file with the State Auditor a bond for the proper performance of his duties in such sum and with such sureties as the Board, with the approval of the Governor, shall fix.

ART. 7. The Board shall adopt and procure a seal impressing the words, "Illinois Surveyors Examining Board," and any device they may select. The Seal shall be in the custody of the Secretary, and used only by him or under his direction.

ART. 8. Out of the funds in the treasury the Board shall first pay the current expenses of carrying out this Act, except their salaries, and out of any remaining funds they may pay to each examiner a sum equal to not more than ten dollars per day for the time necessarily employed in the business of the Board, and in travel to and from its meetings, and the expense of such travel and attendance.

SECTION II.

ARTICLE 1. Any citizen of the United States of lawful age and good moral character may, on payment of ten dollars into the treasury of the Board, present himself as a candidate for a license.

On being satisfied by affidavit, or other evidence, that he possesses those qualifications, the Board shall examine him as to his knowledge of the statutes of the United States and of the State of Illinois relating to the surveying and subdivision of land, practical surveying, the use and adjustment of surveying instruments, and of mathematics as applied to land surveying.

ART. 2. To every candidate accepted by the Board, the Secretary shall, on the order of the Board, entered on their minutes, issue a license, stating the name and residence of the Surveyor, and the date of issue, duly signed and attested under the seal of the Board, on payment by the Surveyor of the further fee of five dollars into the treasury. Any candidate who shall fail to pass a satisfactory examination shall be entitled to a second examination without further charge not less than three months nor more than twelve months thereafter.

ART. 3. But any such candidate who shall file his written application for a license within six months after the taking effect of this Act, and shall prove to the satisfaction of the Board that he has been actively engaged in the business of land surveying for a period of not less than five years, shall be entitled to a license without further examination, on payment of the said further fee of five dollars.

ART. 4. After each meeting at which licenses have been granted, the Board shall through its Secretary file with the State Auditor a report of the name and address of each person licensed at that meeting with the date of the license. And annually the Board shall make full report to the Auditor of their proceedings and of money received and disbursed by them during the year.

SECTION III.

ANNUAL DUES.

ARTICLE 1. On or before the first day of July of the year succeeding that in which his license was issued, and on or before the first day of July annually thereafter, each Illinois Land Surveyor shall pay into the Treasury of the Board three dollars as annual dues. And for each month or fraction of a month of delay of payment thereafter he shall pay the further sum of one dollar.

SECTION IV.

REVOCATION OF LICENSE.

ARTICLE 1. Any license granted under this Act may be revoked by the Board for gross incompetence, or carelessness, dishonest practice, or nonpayment of money due the Board, the accused having twenty days legal notice of the charges against him, the person bringing them, and of the time and place set for hearing them. For such hearing the Board shall have the powers of a court of record sitting in the county where such hearing is held. Witnesses shall be entitled to the same fees as in other courts. Witness fees and costs, shall be taxed and collected as are costs in other courts. The accused shall have the subpœna of the Board for his witnesses, and shall be heard in his defense in person or by counsel. On revocation or lapse of a license the Secretary of the Board shall give written notice thereof to the Auditor of State and to the Clerk of each County, in which the said license has been recorded, who shall file the notice, and shall mark the word "Revoked" and the date of revocation upon his record of the issuance of said license.

ART. 2. The Secretary of the Board shall furnish to any applicant on payment of fifty cents a certificate under the Seal of the Board, in regard of any required license stating the name and address of the person licensed, and the date of issue, and whether the same is still in force; and if not in force, the date of its lapse, and the reason therefor.

SECTION V.

ARTICLE 1. Each Surveyor licensed shall procure a Seal impressing his name and the date of his license, and the words "Illinois Land Surveyor." Every document issued officially by him as such Surveyor shall be stamped with his seal. He shall on receiving his license take and subscribe the Constitutional oath or affirmation of office, to be endorsed on his license.

ART. 2. Any Illinois Land Surveyor may administer to any rodman or chainman employed with or by him on a survey the oath or affirmation for the proper performance of his duty; he may take the evidence, under oath or affirmation, of witnesses, whose evidence may be useful in establishing any part of a survey; he may take and attest by his seal acknowledgment of plats and other documents relating to real estate, in the manner provided for notaries public.

ART. 3. All surveys and proceedings of said surveyor under this Act shall be held to be prima facie correct, subject always to review by the courts. All plats and certificates thereto under his hand and seal shall be received in evidence in all courts in this State, and shall be entitled to be recorded in the county wherein the land affected thereby lies, subject always to the approval thereof by persons designated by law to examine and approve plats.

ART. 4. Every Illinois Land Surveyor shall cause his license to be recorded in the office of the County Clerk of every County wherein he shall make any survey, and shall pay the Clerk a fee of fifty cents therefore. The failure of such surveyor to so file his license for record shall be deemed a sufficient cause for revoking his license, as hereinafter provided.

ART. 5. Each County Clerk shall keep in a book a list of all licenses so recorded by him, with the name and address of the Surveyor and the date of its filing; and he shall notify in writing the Secretary of the Board of such record and the date of its filing.

ART. 6. After six months from the taking effect of this Act, any person, other than an Illinois Land Surveyor, a County Surveyor, or a person employed by and acting for the United States, who shall practice the profession of Land Surveyor, or who, by any sign, printed matter, or otherwise, shall represent himself as a land surveyor, in this State, shall be deemed guilty of a misdemeanor. No plat made or certified by any such person shall be recorded in the office of any county officer.

ART. 7. For the purposes of this Act a Land Surveyor is understood to be a person who uses surveying or measuring instruments to establish one or more corners or boundaries of any tract or lot of land for other persons for a consideration. But any Illinois Land Surveyor may employ skilled assistants to act for, or with him, under his direction and on his responsibility.

ART. 8. Any person not holding a license in force as Illinois Land Surveyor, who shall represent himself to be an Illinois Land Surveyor, or shall issue as such surveyor any plat, certificate or other document, shall be taken as guilty of a misdemeanor.

ART. 9. Any misdemeanor, as defined by this Act, may be punished by fine or imprisonment, or both as provided by statute. Any fine so imposed may be recovered in any proper form of action, in the name of the people of Illinois, on the complaint of any person. Such fine, when collected, shall be paid into the treasury of the county, wherein the offense shall be committed.

SECTION VI.

All Acts or parts of Acts inconsistent with the provisions of this Act are hereby repealed. This Act shall take effect and be in force from and after its approval by the Governor.

J. G. MELLUISH,
S. S. GREELEY,
H. G. PADDOCK,
W. A. HAY,
A. N. TALBOT,
Committee.

The bill was discussed by Messrs. J. A. Harman, H. G. Paddock, J. L. Clark, and P. C. Knight, and Prof. M. S. Ketchum.

A paper entitled "Progress in Invention in the Nineteenth Century" by J. A. Harman was read by the author.

Adjourned until 8 o'clock A. M. January 25.

JANUARY 25, 1901. MORNING SESSION.

The Committee on Matters of Special Legislation which was appointed at the morning session of January 24, made the following report:

To the Members of the Illinois Society of Engineers and Surveyors:

GENTLEMEN: The Committee on Special Legislation would report that they have considered at some length the various matters which have been brought to the attention of the Society. In the matter of sanitary legislation, while the Committee feels the importance of the measure, the time seems to them inopportune to bring it before the legislature, and they recommend that the matter be dropped for the present.

In the matter of the topographic map and the good roads resolution, the Committee recommends that both receive the endorsement of the individual members of the Society. The members should take such steps as they may be able to personally forward these things, especially the matter of the topographic map. Those who are acquainted with members of the legislature should express to them their views and forward a copy of the paper on that subject.

The Society as a whole should confine its labors largely to advancing the bill for licensing land surveyors. The Committee recommends that the bill as presented be endorsed and that a Committee consisting of the incoming President and two members, whom he will appoint, be given charge of it to forward its interests and press it before the legislature. The Committee further recommends that the individual members of the Society take such steps as they can to further the interests of the bill.

D. W. MEAD,
J. W. ALVORD,
J. L. CLARK,
J. H. BURNHAM,
P. C. KNIGHT,
Committee.

On motion of Prof. M. S. Ketchum the report of the Committee was adopted.

On motion of Mr. W. H. Herron the report of the Committee on Topographic Survey was adopted.

A paper entitled "The Staking Out and Calculation of Earthwork" by A. L. Kuehn was read by the author. It was discussed by Profs. A. N. Talbot and M. S. Ketchum and Mr. H. G. Paddock.

The report of the Executive Board was read by the Secretary. It was as follows:

To the Members of the Illinois Society of Engineers and Surveyors:

GENTLEMEN: The Board recommends that the annual dues for members and associate members for the year 1901, be four dollars, except that the dues for all members admitted during the year be two dollars.

The Board also recommends that the salary of the Executive Secretary shall be one hundred and fifty dollars for the year.

The Board has audited the accounts of the Executive Secretary and Treasurer and found them correct.

It is with great pleasure that the Board calls the attention of the Society to the able work of the Secretary, Mr. M. S. Ketchum. When it is remembered that he had but a few months to direct the Society's affairs, the solid advancement made, the increase in membership, and the betterment of the finances, will stand out as strong features of his work. It is to be regretted that private work will prevent Mr. Ketchum from serving further in the capacity of Secretary, and the Board hereby testifies to its sincere appreciation of his successful administration.

C. C. BROWN,
H. G. PADDOCK,
D. W. MEAD,
J. G. MELLUISH.

The report of the Committee on Sewers was read by J. G. Melluish, chairman of the Committee.

A paper entitled "The Indiana, Illinois, and Iowa Railway" by O. C. Whitsell was read by Mr. E. E. R. Tratman.

A paper entitled "The Construction of the Copper Range Railway" by C. C. Stowell was read by Mr. E. E. R. Tratman. It was discussed by Prof. M. S. Ketchum.

The report of the Committee on Exhibit was made by Prof. M. S. Ketchum, chairman of the Committee. It was as follows:

To the Members of the Illinois Society of Engineers and Surveyors:

GENTLEMEN: The exhibit made by Keuffel and Esser was most excellent and it would be proper for the Society to show its appreciation of the courtesy.

M. S. KETCHUM,
Chairman.

On motion the thanks of the Society were extended to Keuffel and Esser for the exhibit made.

The Committee on Press made the following report:

To the Members of the Illinois Society of Engineers and Surveyors:

GENTLEMEN: The Committee on Press reports that it has endeavored to supply the representatives of the Bloomington papers with all the information and material desired, and wishes to express its gratification at the liberal amount of attention and space which these papers have devoted to the proceedings of this meeting. It is in this way that public understanding and appreciation of the work of the Engineer is extended.

The Committee suggests that each member consider himself a Committee of one to prepare a note of all proceedings for the use of the local paper of his town or district, and in this way still further extend the knowledge of the public in regard to this Society in particular, and the engineering profession in general.

M. S. KETCHUM,
E. E. R. TRATMAN,
G. A. GOODENOUGH,
Committee.

The report of the Committee on Mechanical Engineering was read by Mr. D. W. Mead.

The following resolution was read by Prof. A. N. Talbot:

WHEREAS, The Illinois Society of Engineers and Surveyors has been cordially received and entertained by the officials and citizens of Bloomington,

Resolved, That the hearty thanks of the Society be tendered to Mayor Thomas and other city officials for their courteous reception, and for the use of the city hall for the sessions of the Society.

That the very successful efforts of the local members of the Society in arranging for the meeting and in giving the excursion to the many points of interest are appreciated by the Society and its thanks are hereby extended to them.

That the thanks of the Society be tendered to John Eddy, Manager of the Bloomington and Normal Street Railway Co.; the Illinois Club; T. C. Mendenhall, Superintendent of Motive Power of the Chicago and Alton Ry.; Herman Schmidt, Superintendent of Water Works; The Bloomington Electric Light Co.; and the City District Heating Co., for the many courtesies and attentions given the members of the Society.

That the Society congratulates the citizens of Bloomington on the progress made in replacing the business blocks destroyed by fire and expresses the hope that the city will soon recover from the effects of the great fire and the belief that the energy and enterprise shown by the citizens will make Bloomington continue to be one of the most beautiful and progressive cities of Illinois.

The resolution was adopted.

The new President took the chair and announced that the Executive Board had elected A. L. Kuehn Executive Secretary and Treasurer.

Adjourned.

CONSTITUTION AND BY-LAWS

OF THE

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.

AS AMENDED AND ADOPTED AT THE FIFTEENTH ANNUAL MEETING
HELD AT MOLINE, JANUARY, 1900.

CONSTITUTION.

ARTICLE I.—NAME.

This Association shall be called the Illinois Society of Engineers and Surveyors.

ARTICLE II.—OBJECT.

The objects of this Society are the encouragement of professional improvement and of goodfellowship among its members, by meetings for the presentation and discussion of papers on scientific and other kindred topics, and the discussion of such other subjects as may be of interest to its members; the publication of such parts of its proceedings as may be deemed expedient; and the collection and preservation of books, maps, drawings, and other articles of value to the professions represented in its memberships.

ARTICLE III.—MEMBERSHIP.

SECTION 1. Any engineer, architect, surveyor or person directly engaged in the designing, construction or maintenance of engineering or public works is eligible to membership; and any person who is engaged in the sale or manufacture of any supplies or materials used in engineering construction is eligible to associate membership.

SEC. 2. Each candidate for membership or associate membership shall make application in writing to the Executive Secretary on a printed form provided therefor by said Secretary. Such application shall state in writing the name, age, residence, present occupation and the nature and extent of professional service of the applicant; and must be endorsed by three members of the Society. The application shall be accompanied by a deposit of Three Dollars ($3.00) to be applied on account of the admission fee, if the applicant be elected, or refunded if he be not elected.

SEC. 3. Whenever any application for membership shall be received by the Secretary, a copy thereof shall be submitted to the members of the Executive Board within one month from date of the receipt of the same.

It shall be the duty of each member of the Executive Board within ten (10) days from the receipt of any such application, to send his vote upon the electing of such person to membership to the Executive Secretary. PROVIDED, that any applications received within two (2) months immediately preceding any regular meeting of the Society shall be submitted by the Secretary of the Executive Board at its session immediately preceding such meeting of the Society. Four (4) affirmative votes shall elect such person to membership.

The Executive Secretary shall include in his report to the Society the names and postoffice addresses of all persons elected.

SEC. 4. Any person may be elected an honorary member, by a unanimous ballot of all the members, not less than twenty in number, present at any regular meeting of the Society.

Honorary members may present papers and take part in all discussions, and shall be entitled to receive, on request made in writing each year, copies of the annual report of the proceedings of the Society, but they need pay no initiation fee nor dues, and shall have no vote.

SEC. 5. Any three members may present to the Executive Board charges in writing affecting the moral or professional character of any member, whereupon the said Board shall notify the member of such charges, and shall appoint a time and place at which the accusers and the accused may be heard. On an affirmative vote of at least four members of the Board, the charges shall be presented to the Society as soon as it shall be in session, all parties being duly notified, and having opportunity to be heard. On an affirmative vote of three-fourths or more of the members present, said affirmative vote being not less than eighteen in number, said member shall be expelled, and his name shall be struck from the roll; but no public notice of such proceedings shall be given.

SEC. 6. The annual assessment shall be due and payable in advance, and no publications of the Society shall be forwarded to any member till such annual dues be paid.

Any member who shall refuse or neglect for one year after the annual meeting to pay any dues or assessment due from him, shall cease to be a member, and his name shall be struck from the roll. He may be reinstated on payment of the sum so due and of all further sums which would have been due from him had he remained a member up to the time of such reinstatement.

ARTICLE IV.—OFFICERS.

SECTION 1. The officers of this Society shall be a President, a Vice-President, an Executive Secretary-Treasurer and Board of Trustees. The above named officers shall constitute the Executive Board, of which the President shall be ex-officio chairman, and the Executive Secretary ex-officio Secretary.

Two Trustees shall be elected annually and hold office for two years.

SEC. 2. All officers except the Executive Secretary-Treasurer shall be elected annually by ballot by the members, on the second day of the annual meeting, and shall hold office until their successors are elected and qualified.

The Executive Secretary-Treasurer shall be elected annually by the Executive Board.

SEC. 3. The President, Vice-President, Executive Secretary-Treasurer, shall perform the duties usually pertaining to their several offices. The Executive Secretary-Treasurer shall be the custodian of all property of the Society, and shall deliver all such property to his successor, and shall make an annual report. He shall record the proceedings and discussions of the meetings, and shall prepare a copy of them for publication.

As Treasurer, he shall give bond with two approved sureties to such amount as may be required from time to time by the Executive Board, and his bond when approved by said Board, shall be copied on the Journal of the Society, and be deposited with the President. He shall pay only such orders as have been signed by the President, Executive Secretary, and shall make an annual report of all receipts and expenditures, and shall deliver all the Society's books and money in his possession to his successor. The Executive Secretary, in addition to the duties usually pertaining to his office, shall be ex-officio Librarian of the Society, and as such shall collect and preserve all books, pamphlets, papers and documents belonging to the Society. The library of the Society shall be kept in some place central and convenient to access by railroad. He shall deliver all the property of the Society in his possession to his successor.

SEC. 4. The Executive Board shall audit the accounts of the Treasurer and determine the assessment per member for the following year immediately before each annual meeting, and make annually a report to the Society. They shall arrange the program of exercises for each annual meeting and shall have a general care over the affairs of the Society, and shall act for the Society in all general matters between the annual meetings. No moneys shall be expended without a vote of the Executive Board.

SEC. 5. There shall be appointed at each annual meeting the following standing committees of three members each: (*a*) Committee on Surveying; (*b*) Committee on Roads and Pavements; (*c*) Committee on Railroads; (*d*) Committee on Water Works; (*e*) Committee on Drainage; (*f*) Committee on Sewers; (*g*) Committee on Exhibits; (*h*) Committee on Press. It shall be the duty of each committee to collate facts, figures, and items of interest in their respective departments, and make at least one formal report to the Society at the annual meeting following their appointment. The chairman of each committee shall solicit, under the direction of the Executive Board, papers for the annual meeting, and advise with said Board in matters relating to the general subject of the committee's work.

ARTICLE V.—PUBLISHING ANNUAL REPORTS.

The Executive Board shall compile and publish the annual report of the transactions of the Society. They shall include in this report all items of general interest in the proceedings, and such other matters as may seem to them advisable.

ARTICLE VI.—COMPENSATION OF OFFICERS.

The Society may provide for the compensation of its officers for their services whenever deemed advisable.

ARTICLE VII.—AMENDMENTS.

All propositions for amendments of this constitution shall be referred to the Executive Board who shall report to the Society before final adjournment of the annual meeting and such amendment shall be declared adopted by an affirmative vote of two-thirds of the members present, not less than fifteen members voting.

BY-LAWS.

SECTION 1. The annual meetings of this Society shall be in such place as shall be determined by this Society at each previous meeting and at such time in January as shall be determined by the Executive Board. The Executive Board shall notify each member of the Society at least twenty days before the annual meeting.

SEC. 2. Ten members shall constitute a quorum for the transaction of business.

SEC. 3. The meetings of this association shall be governed by "Robert's Rules of Order."

SEC. 4. The order of business shall be fixed by the Executive Board.

SEC. 5. A record of all donations to the Society whether in money, books, maps, models, or other articles of value, with names of the donors, shall be entered by the Executive Secretary in a book provided for that purpose.

SEC. 6. These By-laws may be amended by a two-thirds vote of the members present at any annual meeting, not less than fifteen members voting.

PRESIDENT'S ANNUAL ADDRESS.

BY CHARLES CARROLL BROWN.

For our annual gathering the Secretary has provided a program with a judicious mixture of reports of past achievements and discussion of lines of advancement for the future. It is quite customary for the President of an engineering society on such an occasion as this to give a resumé of the progress of the year in the field cultivated by the members of the society, but I prefer to let these matters take their place in the text books and the engineering periodicals on our library shelves and to call special attention to a few of the needs of the immediate future in our state, which are placed on our program as subjects for discussion.

One of the most widely extended causes of complaint in a prairie state like Illinois is the condition of our roads. There is a wide difference in the opinions of people regarding the proper handling of this subject. The engineer wants a road which can be traveled over at any season of the year, no matter what its cost, while the poor farmer with a small outfit and little return for his badly directed labor cannot see the advantage of taxing himself for this kind of road when the present roads are passable for a fairly large proportion of the year and can be kept passable in good weather with a small amount of labor and no expenditure of money. The engineer has had all the argument with him until the extravagance of some of the claims made by the advocates of good roads have brought about a reaction which bids fair to go as far in the opposite direction with the same disregard for actual fact. As usual, the middle ground is the safer. The engineer must recognize the fact that a good road may cost so much that it is not good economy to build it. That anything which an engineer would call a good road is beyond the limit of economy, for a large majority of the road mileage, especially in the central and southern portions of the state, is a proposition which can hardly be considered open to discussion. The engineer then must accept the situation if he is wise and put himself to experimenting on the making of good enough roads at less cost. In this connection I would suggest a consideration of the results of the experiment recently made by a California road supervisor with hot heavy oil forming an asphaltic sort of surface for a road which Illinois roads can be made to approximate at very little expense.

On the other hand the farmers must finally recognize the fact that the ability to get to town at will and to communicate at pleasure with neighbors, friends and business connections is worth a considerable sum of money. I have had too many experiences with farmers shut out of the world for days on account of bad roads, with good weather, to have any sympathy with the argument that the farmer's time in hauling the crop to market is worth nothing, because he can do it when he has nothing else to do. I am not speaking of the farmer who will not go to see his sick daughter a mile away because it is not easy to get out the team that can get there over the road, nor of the one who burns his corn because it is easier to do that than to take it to market and bring home the equivalent in coal and what little balance of profit there may be, but of the wide awake farmer, who is always on the lookout for business and who utilizes to the utmost the force necessary to carry on the farm; the farmer whose like is coming into possession of the valuable land, more and more extensively every year. I have quoted elsewhere the case of the farmer who lost enough on the difference in price on his wheat between the day of high prices and the first day he could get to market to pay his year's assessment on a good road. His case was, of course, paralleled to some degree by that of every farmer on the road. True economy demands, therefore, a careful study of the conditions of the area served by a road, and a decision as to character and cost of road in accordance with the data thus obtained, eliminating theories, attractive or otherwise, which cannot stand the test of these facts.

We have some good papers upon the subject on the program and hope to have present for the discussion some persons prominent in the recent agitation of the matter.

Another matter which is not yet of much interest in this state is of growing importance and is one which it will be worth while to begin the discussion of. This is the matter of grade crossings. Near the cities, large and small, the necessity of a separation of the grades of roads and railroads is increasing and the expense of making the change is also increasing. Not only this but the number of crossings is daily becoming greater. Money will be saved by an early consideration of the matter. Press reports say that one of our members has made some plans for this improvement for one of our Illinois towns. Perhaps 25 per cent. of the grade crossings in the immediate vicinity of Bloomington could be eliminated with but little labor or expense beyond the building of the necessary road or railroad bridge over the opening, and there are many other cities and towns in similar condition. It is worth looking into at once. We have one or two papers on our program on the more elaborate and more expensive treatments of the problem necessary in large cities.

Another proposition which we have discussed to some extent will be of much assistance in developing public opinion on both these subjects and in reducing the first expense of preparing plans and estimates, thus making it possible to get definite figures as a basis for the preliminary agitation, something which no one likes to pay for and for lack of which much time is lost and there is much mis-direction of effort. This is the proposition for a topographical survey of the state under the auspices of and partly at the expense of the United States Geological survey. A representative of the survey office is present to deliver a paper and to explain any matters on which our members may desire enlightenment.

Let us give him plenty of talking to do in developing the matter both from the economic and from the engineering standpoints.

We also have to consider one phase of a large question of paramount interest to engineers. Papers are not numerous but it is hoped that some members are prepared and willing to take up the discussion.

While engineering is a profession perhaps of the highest rank in the material world, it is so closely allied with the world of business that its ethical status differs somewhat from that of other professions. The profession of architecture is similar to and to a large extent is the same, though the professional element is perhaps a little more strongly marked. Aside from salaried positions, a large proportion of them in the public service, there are very few engineers devoting themselves entirely to the practice of the profession of engineering, most engineers finding the use of their talents in the field of business more profitable and perhaps more congenial than in the strict lines of professional practice. Such a law as that described in one of the papers to be given is, therefore, not strictly applicable to engineers, or at least the number of engineers to which it would be applicable is so small that the interest in the passage of such a law is not sufficient to secure its consideration. There is need, however, for some similar regulation of the qualifications of engineers in public employment. A competent law would help the standing of the engineer more than anything else which could be devised. The regulation of the practice of surveying is, in a sense, more nearly like the regulation of the practice of architecture, since most of the clients of the surveyor, like those of the architect, are private persons. But in another sense it is more like that of the practice of plumbing, since it is the ability of the surveyor to handle his tools, instruments and mathematical formula and tables, which it is desired to test. In the case of the engineer, as in that of the architect, it is his ability to design as well as to carry out the designs of others, which should be the subject of test. The regulation of the practice of surveying, therefore, cannot be combined in the same law with that of the regulation of the qualifications of engineers in public service, without so dividing it into classes to make practically two laws. It might be good policy, however, to make the combinations so that the bill could have the support of all the engineers and surveyors. Perhaps with this plan it would be possible to secure the favorable consideration from the legislature, which has heretofore not been attainable. We will hope for a full consideration of all branches of the subject when the proper place in the program has been reached.

COST OF WAGON TRANSPORTATION.

BY IRA O. BAKER.

One of the advantages of any proposed road improvement is the decreased cost of transportation, but reliable data as to the economy of improved roads is lamentably scarce. It is the purpose of this paper to inquire into the cost of wagon transportation with a view of securing data to be used in determining the possible saving to be derived from any proposed road improvement. It is hoped that in the discussion members will supply additional data.

In the first place a distinction must be made between work done by those whose chief purpose is transportation, and that done by those to whom transportation is a mere incident of a business organized for a different purpose. The first class of workers is represented by the man whose sole business is to sell transportation, and the second is represented by the farmer whose business is organized to produce farm products, the transportation of which to market is ordinarily a very small part of his business. For brevity, the first class will be referred to as freighters and the second as farmers.

The cost of transportation is more to the freighter than to the farmer. In the first place, feed, barn rent, and usually labor costs the farmer less than the freighter. For three months of the year it costs many farmers absolutely nothing to feed their teams. In the second place the freight carried by the freighter must pay a share of the expense incurred while the team is idle; while the hauling done by the farmer is done usually during periods of idleness either comparative or absolute, in his chief business. Farther, the power employed by farmers in transportation costs practically nothing, since more horses are required to cultivate the crops than to transport them to market. This may not be true of dairymen and gardeners, but they are not representative farmers, since according to the U. S. census, dairymen, gardeners, vinegrowers, florists, and nurserymen constitute only one fifty-seventh of the so-called farming class. Again, when the farmer uses his teams in transportation, it is unnecessary to feed them as heavily as does the freighter, since the service is comparatively brief. There are a few minor differences in the same line that need not be discussed here. In short, to the farmer transportation is a by-product, and it is a well established principle that to a manufacturer a by-product costs little or nothing.

In discussing the cost of wagon transportation in reference to road improvement, consideration should be given only to hauling in which the load is equal to the full capacity of the team for the particular condition of the roads. A farmer may employ a two-horse team to take a bushel of potatoes to town, or a grocery wagon may make a trip to deliver a pound of cheese, but the partial load is entirely independent of the conditions of the roads. Farther, it is necessary to notice that only the rate for wagon loads should be considered. If a number of packages are carried in the same load for different parties, part of the charge is to cover the cost of collection, distribution, possible partial loads, etc., and therefore only part of the charge is for transportation proper.

Most of the hauling upon the country roads is done by the farmers; but the cost to freighters will be considered first to throw light upon the cost of wagon transportation to farmers.

COST TO FREIGHTERS.

The following data are all that are readily obtainable concerning the actual cost of wagon transportation to freighters.

1. Some years ago San Francisco merchants, because of excessive railroad freights, shipped goods by wagon from Stockton up the San Joaquin valley to Fresno, a distance of 146 miles, at 3.5

cents per ton-mile. Presumably the road was unimproved, although in a good condition for one of that class. The price is surprisingly small, probably due in part to a return load. This example is hardly representative of ordinary transportation on the wagon roads, owing to the long distance and large loads.

2. The author is informed that in the mountain region of the northwest the usual rate is 1 cent per 100 pounds per mile, which is equivalent to 20 cents per ton-mile. This rate obtains between Red Rock, Montana, and Salmon City, Idaho, a distance of 70 miles over the continental divide, one terminus being 1500 to 2000 feet below the summit and the other 3000 feet. The road was unimproved with a considerable intermediate rise and fall. This example is not representative of the average hauling on country roads, because of the long haul and because of the rise and fall.

A similar rate has obtained in hauling provisions required in the construction of a railroad in Oklahoma (*Engineering News,* Vol. 35, Jan. 16, 1896). No details are given, but in all probability this was over roads little, if any, better than mere trail, and probably required the teams to ford the streams. It is distinctly stated that there was no return load.

3. In *Engineering News,* Vol. 35 (Jan. 16, 1896), page 43, are a few meager details showing that wagon transportation in 1877 in connection with the construction of the Boston Water Works, cost 12 cents per ton-mile. It is stated that the "roads were good, and were probably better than the average country road." It is also stated that the "compensation was hardly considered fair."

4. For several years the University of Illinois paid 30 cents per ton for hauling coal. The haul was almost exactly 1 mile, and therefore the cost was 30 cents per ton-mile. The coal was used for heating, and therefore the work was done chiefly during the winter months. The storage capacity was sufficient for 20 to 30 days' consumption, and consequently there was a little latitude in choosing the time for delivery. The roads were practically level and the surface was loam, and frequently almost impassable, sometimes four

horses being able to haul only one ton. This is an example of the cost in winter, i. e., when the roads are in their worst condition, and in a locality where they probably get as bad as anywhere.

5. Later, when the consumption of coal at the University had greatly increased and the streets had been paved nearly all the way, the price was 20 cents per ton for a haul of 1 mile, which price prevailed for three years. The contractor thought he barely made expenses, chiefly because the unpaved roads were very muddy.

Then for one year the price was 19 cents per ton for three-fourths of a mile, or 25.3 cents per ton-mile. This haul was entirely on brick pavements. Apparently the contractor lost money, owing chiefly to the difficulty of getting cars switched promptly.

The next year, when the annual consumption was 5000 tons the price by a different bidder was 20 cents with the expectation of hauling the same distance, but the coal arrived by a different railroad, thus making the haul 1.5 miles, and therefore the price was 13⅓ cents per ton-mile. This also was upon brick pavements. The men load, haul, and unload, five loads of 3 tons each day for a day's work, an equivalent of 22.5 ton-miles per day, some of the men completing the stint in eight hours. According to estimates of the writer the contractor, after paying for labor, feed, barn rent, interest, maintenance, and depreciation, has 10 per cent. to pay for superintendence and contingencies. He looks after the work closely, and while not making any fabulous sum is satisfied with his contract. The last item is an example of the cost of transportation under the most favorable conditions for freighters.

The last item affords an interesting illustration of an important principle. As just stated the cost of hauling 1½ miles was 20 cents per ton, which includes loading and unloading. The Illinois Central railroad in the same town regularly pays men $1.50 per day, for unloading coal from cars. All the coal used at a division headquarters has been handled in this way for several years past. The men employed handle about 30 tons per day, making the price 5 cents per ton, exclusive of superintendence. If we consider the loading of the University coal to be the same price, then the cost for simply hauling is 10 cents per ton for 1½ miles or 6⅔ cents per ton-mile. However, this is not a proper basis of computation. The Illinois Central men handle three tons per hour, but the teamsters handle an equal quantity in a little less than half of the time. The former maintain their rate all day, the latter for only a small part of the day; and consequently the latter should work at a considerably more rapid rate. The sole business of the former is to shovel coal, while with the latter shoveling coal is comparatively a small part of his duty. In the above case the cost of loading and unloading is about one quarter of the total cost of delivery.*

6. For several years large quantities of sand and gravel have been delivered a distance of two miles, over level roads, during the building seasons by contract for 20 cents per ton-mile, including loading, and usually unloading, with shovel. In the same locality for a number of years, large quantities of clay have been delivered to a brick and tile yard, during the working season, at 20 cents per ton-mile, including loading with shovel. Brick are loaded and hauled and unloaded for substantially the same price. These items are examples of the cost during the summer when the earth roads are in their best condition.

COST TO FARMERS.

7. Non-resident land owners in Central Illinois frequently hire corn delivered for 9 to 11 cents per ton-mile. This price has obtained over large areas for 10 or 15 years. The contract is usually taken by the man who does the shelling, he hiring farmers to do the hauling. The author knows of these prices being obtained frequently during the corn-planting season, when the farmers are most busy and when the roads are certainly not at their best.

8. Many times farmers haul corn to the farther market for a slight difference in price, the difference in price being equivalent to

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*Since the above was presented one of the author's student's called his attention to the following example: The cost of hauling coal to the Insane Asylum at Anna, Ill., is 17 cents per ton for a haul of nearly 1½ miles over hilly gravel roads, which is equal to 12 cents per ton-mile including loading and unloading with a shovel. In one place the grade is 8 per cent; and the rise is about 130 ft.

6 to 9 cents per ton-mile for the hauling. The lower of these prices usually obtains when the roads are good in the winter season while there is little or no farm work to do.

9. The Standard Oil Co. has a number of distributing points in Illinois from which they deliver kerosene, etc., to the nearby towns with tank wagons. These distributing points are so numerous as to practically cover the entire state, and the same system is used in at least several other states. The Company owns its own teams and wagons. In Central Illinois it delivers its products 20 miles over common earth roads with a tank wagon instead of shipping by railroad. In a number of cases examined by the author for the purpose of this record, the railroad rate is 14 to 15 cents per ton-mile. Apparently then the Standard Oil Co. thinks it cheaper to deliver oil by wagon than to ship it by rail at 14 to 15 cents per ton-mile. This is done when four, and sometimes when six, horses are required to haul a ton. In one sense the use of four or six horses to haul a ton makes the cost by wagon about twice or thrice that by rail. Why then does the Standard Oil Co. haul oil at an apparent loss? The answer is that the men are paid by the day and the horses must be fed whether they work or not, and therefore it is better for them to earn something than to remain idle. This is exactly the argument that the farmer makes in trying to show that as a rule it costs him little or nothing to market his crops. As evidence that the Company knows what it is doing, it may be stated that all feed issued to the drivers is weighed, and if the amount or cost of feed per team differs materially from the standard adopted by the Company the matter is carefully inquired into by the central office. The horses are weighed at stated intervals to see that they maintain their normal condition. There are several very interesting features in this case, but as they relate entirely to the mercantile side of the question and do not effect the above facts, they are not mentioned here.

10. In discussions of this character, attempts are frequently made to determine the value per day of a team and driver. A few data on this subject will now be given.

Some years ago a millionaire purchased a thousand or more acres of land and started a scientific farm. Careful accounts were kept with the several departments of the farm work. The feed of a two-horse team was reckoned at 50 cents per day, and its labor at the same sum. A driver was assumed to cost $1.00 per day. Therefore the price of a man and team was $2.00 per day. At these prices the teams were in considerable demand and were freely hired out. Every department of the farm showed a profit, but the horse account was the most profitable.

The University of Illlinois Agricultural Experiment Station in Bulletin No. 50 (1898) gives the data employed in trying to find the cost of raising corn. The data represents 316 replies to 1000 circulars sent to all parts of the state of Illinois. The farmers were asked: "What is the rate of wages of man and team?" The average for each of 76 counties varies from $1.40 to $2.74, the average of all being $2.13. It should be remembered that the price returned was the value of the time employed in raising and gathering the corn, and is therefore more than at any other time of the year.*

The author knows of an intelligent, enterprising, successful farmer who, when there is nothing for his teams to do at home, seeks an opportunity to haul grain for his neighbors at $1.00 per day.

This seems very small; but several intelligent and successful farmers, in fact all consulted, say that the man makes money by so doing. This price does not seem so small, if we notice that it is practically half the price given above for the average value of a team and driver in cultivating the corn crop.

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*It may be mentioned that, according to this Bulletin, in hauling 311,000 bushels of corn, shelled and unshelled, the average load was 62 bushels. If it were all shelled, this is equivalent to at least 2.2 tons. Therefore these replies indicate that the average load of corn is somewhere from 1¾ to 2¼ tons, which is considerably more than is frequently claimed.

It is also interesting to note that the average haul for this corn was 3.2 miles, which also is considerably less than has been claimed.

Finally, the cost of making this corn at busy season prices was 1.28 cents per bushel, which is about one-twelfth of the cost of production, while an official writer on good roads claims that the average cost of transportation from farm to market is one quarter of the "value" of the crop. Or, the cost of hauling this corn at the prices set by the farmers for a day's work of man and team during the busy season was 14.4 cents per ton-mile. During the idle season the farmer counts the value of a day's work very much less.

CONCLUSION.

Of course a single example of price is not conclusive as to cost, but a unanimity of several prices is fair evidence as to cost. The preceding data are presented with the belief that they are representative, and that they warrant the following conclusions:

1. Except in rare cases, the maximum cost, to freighters, on earth roads is not more than 25 cents per ton-mile; and during the summer months, the cost to freighters on level loam roads is about 20 cents per ton-mile.

2. With a little choice as to the time of doing the work, the cost to the farmer is not more than 10 to 12 cents per ton-mile on earth roads; and when farm work is not pressing the cost is not more than 6 to 9 cents per ton-mile.

3. The cost to farmers of hauling upon the best stone roads would not be much less than the cost upon earth roads when in their best condition, since the best earth roads are nearly as good as stone roads. Farther, the size of the load is limited by the capacity of the wagon, and in most localities the wagon is designed primarily for general farm work and moderately light loads on the roads; and, therefore, with hard roads the load could not be much increased without a change in the wagon which will unfit it for general farm work.

4. The cost of hauling upon stone roads is much less than upon muddy earth roads, but most farm produce that goes to market in full loads can wait for a favorable condition of the earth road.

The final conclusion to be drawn from the preceding discussion is that the possible saving in the transportation of freight by wagons through road improvement will be an insignificant part of the cost of such improvement. This does not mean that the roads should not be improved; but it does mean that no great improvement can be justified alone on the ground of reducing the cost of transportation. Farmers are unanimously of the opinion that the cost to them of wagon transportation is a matter of small moment. It is believed that the preceding discussion shows that this opinion is correct; and it also shows why farmers have been so little influenced, at least favorably, by the arguments of road reformers who claim that the farmer is losing vast sums annually by not having the benefit of permanently hard roads upon which to haul his products to market.

Good roads are desirable for the same reason that a man buys a carriage or builds a fine house, i. e., because they are a comfort and a pleasure; and not because they are financially profitable.

DISCUSSION.

MR. S. A. BULLARD: The cost of loading and unloading, which is not affected by the condition of the roads, varies in its proportion of the total cost. In short hauls it may amount to a great deal more than the cost of the hauling proper. A farmer living four miles from a depot would have just as much work loading and unloading as if he lived only one mile away; and the cost per ton-mile would be less for the long haul than for the short haul.

MR. J. H. BURNHAM: The speaker was much interested in the paper because the author gave actual figures. However, he objects to the conclusion because he believes that the figures are altogether too low. A farmer who works a team for a dollar a day is working too cheaply; he is not charging for their time and wear on horses and wagon.

MR. H. H. GROSS: The speaker is acquainted with the matter of the Standard Oil Company. The reason that they ship by wagon tank instead of by rail is, that they may deliver at a customer's door, and not because it is cheaper. If shipments were made by rail a man would have to be kept at the tank and the cost of getting the oil to the customer would be about as much as if it were shipped by wagon. Again, in many cases wagon transportation is all that is available; in three counties, for example, there are no railroads at all.

The cost of the transportation is not a very important matter. A farmer is most interested in his ability to get crops to market at any time. This depends upon the condition of the roads. Hauling can only be done when the roads are in condition and not when the farmer desires to do it, which is when the market is high. Several farmers have informed the speaker that if they could do business on the condition of the market instead of the condition of the roads, there would be a difference of two or three cents per bushel. The prices of many articles depend upon the condition of the roads; when they are bad farmers can not haul to market consequently there is a scarcity and prices rise. Just as soon as the roads are again in good condition there is a great influx to the market, resulting in an oversupply and prices fall.

PROF. M. S. KETCHUM: As a boy on the farm the speaker has worked many a day with a team in payment for a day's labor without a team. In Illinois it is a general custom to make no allowance in exchanging work on the farm for the use of a team. The reasons for this are; (1), that the work with a team is easier than without and (2), that the farmer must feed the team whether it works or not; and would therefore rather work his horses for their feed than to allow them to stand idle in the barn. This custom applies to all kinds of farm work including the hauling of grain to market.

It is evident from the foregoing that there is transportation going to waste on the farm for a large part of the year at least, and that the cost per day to the farmer in hauling grain to market is practically the cost of a day's labor for a man without a team, and not the cost of a day's labor of a man and a team as it would be in the case of a freighter. This same principle is recognized in lines of commercial activity, and we see the cost of production of many products determined not on the basis of manufacturing them alone, but on the basis of their being by-products. Transportation is a by-product in farming and in estimating the cost to the farmer this fact should be considered.

In the economical operation of our railways this principal is recognized and applied. The cost of running a train is practically independent of whether it is fully or partially loaded. Now if a passenger train is only partially loaded there is certainly transportation being manufactured that is not being used and might better be sold at a nominal price than wasted. It is certainly no more nearly correct to estimate the cost to the farmer of hauling his grain to market on the same basis as in the case of freighter than to estimate the cost of carrying additional passengers on any particular train on the basis of the number of passengers then on board. There is certainly transportation being manufactured in both cases that will be wasted if it is not used.

The price for which farmers are willing to do hauling for highway bridge contractors and others is not a fair valuation of the farmer's estimate of the cost to him of hauling his grain to market, for the reason that he will not leave his business to take up work with which he is not familiar unless he is well repaid for his time. The speaker has had several years experience in the northwest as the agent of a large bridge works and does not remember of ever paying more than 25c per ton-mile to freighters for hauling bridge material, the usual price being 20c per ton-mile. If this is the cost to freighters in a mountainous country the cost to farmers in a country where the cost of labor and living is less must certainly be very much less.

A favorite argument in favor of hard roads is that the farmer will then be able to sell his grain when the market is best and thus make several cents per bushel. Those advancing this argument do not take into account the bad judgment of the farmer, nor do they seem to appreciate the fact that with ideal conditions much more grain and live stock is sold on a falling market than is sold on a rising market. With present storage facilities it is now possible for the farmer to store his grain at the railway station and sell it at his pleasure, the storage being usually free for thirty days with a nominal price for a longer time.

It seems to the speaker that the question of building any particular hard road is as much an engineering problem as is the building of a railroad and should depend upon first cost, cost of maintenance and estimated revenue or profit to those building it. There is no question but what it will be advantageous to build hard roads in many localities in Illinois. The building of hard roads would seem, however, to be a local question and not one calling for state legislation.

THE PRESIDENT: If farmers can get crops to market at proper times it will be greatly to their benefit. It will be beneficial to everyone concerned because the supply will not fluctuate so much. If this phase of the matter is taken into account the discussion will be on a sounder basis.

EXPENDITURES FOR EARTH ROADS.

BY IRA O. BAKER.

To determine the amount of money spent upon earth roads, the writer sent a circular to each township in Champaign County asking for certain details as to the receipts and expenditures for road purposes during the year 1900. The writer also visited the office of the County Treasurer and got certain information to be used in checking that received from the township officials. From recent township maps was obtained the area of each township and the number of miles of road in each.

Champaign County is 28 miles east and west by 36 miles north and south, and contains almost exactly 1000 square miles. It lies in the corn belt, and is prairie, broken only by narrow strips of timber along four small streams, three of which rise in the county. Most of the land originally timbered is now in cultivation. Farm lands without buildings sell for $80 to $100 per acre. The county contains 153 miles of railroads, or one mile of railroad for each 6⅔ square miles of area. The population is 47,000, of which 15,000 are in the adjoining cities of Champaign and Urbana.

In Champaign Couty there is 1.97 mile of public rural highway for each square mile of area. This includes neither streets nor roads within incorporated cities or villages, which must be cared for by the incorporation, nor the area of municipalities. Notice that there are almost exactly two miles of road for each square mile of area; and therefore in the statistics to follow when data are given per mile of road, the quantity may be doubled and considered as being per square mile.

In Illinois three forms of road taxes may be levied, viz.: a poll tax payable in labor or cash, a district road tax payable in labor or cash, and a road and bridge tax payable in cash. In computing the poll tax a day's labor is counted $1.00. In computing the district road tax a day's labor of a man is considered equivalent to $1.25, and of a team and wagon or plow $1.50. A team, wagon, and driver are then, in law, equivalent to $2.75 per day.

All the townships from which reports have been received assess a poll tax varying from $1.00 to $2.00 per individual. The exemptions are numerous and collections are difficult, therefore the total receipts are small. The poll tax is equivalent to $2.49 per mile of road.

There are twenty-eight townships in Champaign County, and half of them levy a district road tax, which in every case is uniform over the township. The levy varies from 10 cents to 50 cents per $100 of the assessed valuation,* the average being 25 cents. Nearly all of this tax is paid in labor, only a few non-resident land-owners paying cash. For the townships levying this tax, the average is $8.44 per mile, the range being from $3.51 to $13.39. This tax and the poll tax are usually paid in labor, and therefore in half the townships the total labor tax is $2.49+$8.44=$10.93 per mile, while in the other half it is $2.49.

For the townships reporting, the average levy of the road and bridge tax was 56 cents per $100 of the assessed valuation, the range being from 25 cents to $1.00. The average taxes per mile are $23.93, the range being from $11.70 to $34.70.

The total labor and cash tax is $33.23 per mile, the range being from $16.60 to $52.70. In other words, Champaign County is spending on its country roads in labor and cash an average of $33.23 per mile, the range for the different townships being from $16.60 to $52.70.

All the townships reporting spent money for new "iron" bridges, the average being equivalent to $16.20 for each mile of road in the township, the range being from $6.30 to $37.40. In Illinois the county is by law required to pay half the cost of the larger bridges, i. e., of those costing more than a certain per cent. of the assessed value of the township. The above does not include the amount paid by the county. During the year 1900 Champaign County spent $10,900 for bridges. This amount was not uniformly distributed over the county, but was equivalent to $5.83 for each mile of road in the county, or $11.04 per mile of road of the townships in which it was spent. In the money spent for bridges, Champaign County is probably exceptional. The county is comparatively flat and is crossed by no large streams, and therefore from this reason one would expect it to spend less for new bridges than the average. On the other hand, the county has a number of "dredged ditches," and for this reason it may have more bridges than other parts of the state. Again, the county is building first-class steel bridges on high grade stone masonry, and therefore it is probable that Champaign County is spending more money for bridges than most other parts of the state.

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*For the information of non-residents of the State, it may be well to say that the assessed value is by law one fifth of the cash value.

Drainage cost $6.32 per mile. Part of this expense was for outlets through dredged ditches; and the most, if not all, of the remainder was for tile drains. Three quarters of the townships spent money for tile culverts, the average being equivalent to $1.32 per mile of road. All of the townships reported money spent for repairs of bridges and culverts, the average being equivalent to $2.93 per mile of road. Eighty per cent. of the townships reported expenditures for grading (not simply smoothing and leveling), the average being equivalent to $1.43 for each mile of road in the township. All reported expenses for smoothing and leveling the roads (not grading), the average per mile of road in the township being $2.83. The range in this item is proportionally very great, being from 40 cents to $10.00 per mile. Three quarters of the townships reported cost of mowing the roadsides, the average being $1.14 per mile. The total of the preceding expenses is $32.17 per mile of road, or $64 per square mile, or 10 cents per acre.

The average expense is less than the average tax received, since the latter includes expenses of administration. Unfortunately no inquiry was made as to the cost of administration and consequently no data can be given. However, to prevent misapprehension, it is necessary to say that the cost of administration is certainly greater than the difference between the receipts and expenditures reported above. There are slight errors in the returns owing to different interpretation of the inquiries, particularly with reference to the poll tax; but it is reasonably certain that the errors do not materially affect the above use of the data.

The writer has a few reports from townships in other counties in the Corn Belt; and apparently Champaign County is representative, except that where there is gravel within easy reach they are spending considerable sums to construct gravel roads, in addition to expenditures substantially as in Champaign County.

The expenditures for now "iron" bridges, tile culverts, and drainage amounted to $23.84 per mile, or nearly three quarters of the total expense, and are for permanent improvements. This work was almost certainly done by contract. If grading be considered a permanent improvement, then $25.27 per mile was spent for betterments. Repairs of bridges and culverts, smoothing the roads, and mowing the roadside must be regarded as expenses of maintenance, the total for these items being $6.90 per mile.

In conclusion, a few points deserve brief mention:

1. Almost three-fourths of the expenditures were certainly done by contract, and therefore the criticism frequently urged against the labor system does not apply to three-fourths of the road expenses.

2. At present the expenditures for maintenance proper is so small as to make it impracticable to delegate this work to one or more who shall give their whole time to the work.

3. The expenditures for permanent improvements are needed for present conditions, and would be absolutely necessary before hard roads could be wisely introduced.

4. Until farmers are willing to tax themselves more than $32 per annum per mile for earth roads, it is needless to expect them to willingly pay for hard roads.

5. Until farmers wear more expensive clothing and live in finer homes, it is unreasonable to expect them willingly to support the most luxurious public highways.

DISCUSSION.

MR. J. H. BURNHAM: It is to be noted from the paper that in Champaign County road tax of over 80 cents per hundred dollars is paid. In McLean County the tax amounts to only 46 cents, however, here are built not nearly so many permanent bridges.

DISCUSSION.

THE IMPROVEMENT OF COUNTRY ROADS.

PROF. I. O. BAKER: Practically all the roads in the state are earth roads. More attention should be given to them. They can be improved in two ways: First, by giving more attention to drainage by tile. There should be at least a line of tile on the side of every road. Second, the surface should be kept smooth, with a uniform slope from the center of the road to the side ditch. The slope should be only steep enough to carry the water quickly to the side ditch. The maintenance of this slope requires constant attention. Earth roads deteriorate and become muddy because ruts form, which hold the water and soften the road. If these depressions were prevented, the roads would not become muddy—at least not very muddy. The surface can be kept smooth by going over it at the proper time with a drag, or harrow, or a road machine. In the winter and early spring there is usually only a brief time when the roads are in suitable condition thus to be leveled down with a harrow or light drag. Later in the spring this work can be done, but less economically, with a road machine or road plane.

Until the farmer cares for the earth road better than at present, it is folly even to talk of hard roads. One reason for the present unsatisfactory condition of the earth roads is the ill-advised and extravagant talk about the advantage of hard roads to the farmer. He knows that there is little or no truth in the arguments of the good road enthusiast, and consequently turns a deaf ear to all road questions.

Some of the common arguments that have been advanced in favor of hard roads are most astonishing. For example, a large well printed and elaborate pamphlet, in calculating the cost of bad roads to the farmer includes all the horses (old and young, on the farm and in the city) and all the cattle (cows, calves and beef cattle) as draft animals, and computes the value of their labor at 50 cents per day, and the cost of their keep at another 50 cents; and than says that at least half of this vast sum could be saved by hard roads. The computed "saving" is indeed an appalling sum. Any farmer knows that the result is ridiculous, and as a consequence pays no attention to any arguments offered on that side of the road question. Most of the common arguments are misrepresentations or over-estimates, and the manner of presentation is not calculated to win converts. In the pamphlet mentioned above, farmers are frequently referred to as "fools," "ignoramuses," etc.

Is it not remarkable that only the hard road advocate has discovered what vast sums the farmer is losing by the lack of hard roads? It is certainly true that the farmers are nearly unanimous that hard roads would save them little or nothing. Farmers are not backward in purchasing improved farm tools or labor-saving machinery. Is it not astonishing that they are nearly all opposed to hard roads on financial grounds when hard roads would save them such prodigious sums? When eight million farmers are practically unanimous on a question, about which they have more knowledge than anybody else, it is safe to conclude that they are nearly right. Some farmers are in favor of hard roads on other than financial grounds. Of course, in certain limited localities, hard roads are really a financial benefit to gardeners, dairymen, fruit growers, etc., and under certain conditions also to a few farmers; but that does not prove that hard roads will be financially beneficial to the average farmer. It is also true that in some localities hard roads have changed rural property into suburban property, but that does not prove that there would be a like rise in value of agricultural land due to the construction of hard roads. Engineers at least ought to be reasonable in their arguments on the road question.

MR. P. C. KNIGHT: The speaker has heard of oil being used on earth roads, giving excellent results. Mud will not stick to wagon wheels and the roads will dry up much quicker. The cost is said to be small.

As to the use of the road scraper, it is certain that it produces a smooth dry road; however, the effect is lost as soon as the road becomes wet. The speaker knows of the scraper being used on what is perhaps the worst stretch of road in the state. As long as the road is dry it is excellent, but a slight rain will make it as impassable as ever.

In Pontiac three miles of stone road have been built at a cost of $30,000, yet in spite of this expensive construction it costs no less for maintenance than any other road in the county. Gravel roads in the county cost about $3000 per mile. The gravel is close at hand.

MR. H. H. GROSS: The question of oil on roads is still in the experimental stage; but it is hoped that it will be useful in the country. In California the cost of the oil is nominal, and the item of $200.00 a mile cannot be considered as representative. Machinery has been used to spread the oil on the road so as to work it in two or three inches deep. It keeps the roads in pretty good shape. In California it is used more to keep down the dust.

Prof. Baker has stated that farmers do not look favorably on the question of hard roads, and that because they are unanimous they are probably right. The Department of Agriculture looks after the interest of the farmers; it is advocating hard roads because it believes them to be beneficial to farmers. That the farmers may be mistaken in their position is possible. Twenty-five years ago they said tile drains would ruin the country; yet these have been found to be of great value.

The ground freezes, ordinarily, after the November rains when the roads are badly cut up; this leaves them rough and almost impassable. The farmer must sell his produce, not when the market is right, but when the roads will permit; he has produce that the city wants and is ready to pay a good price for, but he cannot deliver it. When the roads are bad, prices are often the best, as the supply is short on account of the roads; when the roads improve prices usually go down owing to the heavy shipments and over supply.

The inability to take advantage of the market is costing the farmers of Illinois, at the lowest estimate, two cents upon every bushel of grain they raise; to say nothing of the inconvenience and discomfort of being mud bound, and the extra expense of hauling produce to the market over poor roads. An eminent authority on agriculture says that the farmer in any community having hard roads which will enable him to market his crops any day in the year, can by watching the markets and taking advantage of good prices, gain from three to five cents on a bushel of his grain and one-half cent to one cent a pound on stock over and above what he can ordinarily get, when for weeks at a time he is mud bound and can not deliver his crops nor keep in touch with the market. He goes further and says: "This means an increase of the cash profits on the farm of from seventy-five cents to two dollars per acre. There can be no doubt that good, hard, every-day-in-the-year roads are worth one hundred to three hundred dollars per year for every quarter section reached by them."

Good roads will save money to every man, woman and child in the state; therefore all should help pay for them. The saving effected by good roads would build them every five years. In other words, they will pay twenty per cent. on their cost, every year.

The last biennial report of the Illinois State Board of Equalization shows total assessed valuation of all forms of property for the entire state to be $953,000,000.00, of which Cook County, including Chicago, contributes $381,000,000.00 or 40% of the state total. Farmers and farm property come next with $315,000,000.00 or 33⅓%. The balance $257,000,000.00 or 26⅔% is made up of cities, towns, villages and corporation property outside of Cook County. Thus, in any good roads law, providing for state aid in the building of roads, only ⅓ of the state's proportion is paid by the agricultural interests of Illinois. Illinois can and should give substantial aid in building roads on the main thoroughfares; we should have as favorable laws as New York or New Jersey.

To assist in building good permanent roads, the state should levy a one mill tax on the property of the entire state. This will produce nearly a million dollars a year. Great as the sum is it would not be felt when spread over so much property. It would be less than one cent an acre on average farm property throughout the state. This tax if used to pay for one-third of the cost of permanent hard roads would permit the building of two thousand miles per year. When it is considered that experience everywhere shows that every dollar expended in building permanent hard roads adds from three to five dollars to the value of all land served by them, action should be taken at once.

Only the main roads should be macadamized; and these should be from nine to twelve feet wide, and in every case there should be a dirt road provided alongside. This dirt road, when dry and hard, is the best road known, and will be used in preference to the stone or gravel road. This method lengthens the life of the hard road, which if properly constructed and occasionally looked after will last hundreds of years. The old Roman roads, built two thousand years ago in Europe, are still good.

The cost of building hard roads, twelve feet wide, where material is convenient, as in many parts of the northern and extreme southern parts of the state, will be from a minimum of $1,000.00 per mile to a maximum of $3,000.00 per mile. In other portions where the material would have to be shipped some distance by rail, the expense will run from $2,000.00 to $4,000.00 per mile. For the purpose of calculation $3,000.00 per mile is a perfectly safe figure. Under ordinary conditions twelve to eighteen miles of hard roads in a township will cover most of the main thoroughfares; sixteen miles, say, at $3,000.00 makes $48,000.00. Considering that there may be some expensive bridges to build, or some extra heavy hills to cut down, an expenditure of $60,000.00 per township is certainly an outside figure.

The question of state aid in building country roads is vital and goes to the heart of the whole matter. As the answer depends upon the size of farm, its value, the assessed value of the township and the county, and location, no answer can be given that will fit every case. The following example, which is based upon conditions that represent the average situation in Illinois, will furnish an approximate answer. Let us assume that John Jones owns a quarter section in a township in central Illinois where the county is made up of sixteen townships; the records of the State Board of Equalization show that $1,800.00 is an average assessed valuation of such a farm. The assessed valuation of a farming township is $300,000.00 or over; but we take $300,000.00 as the basis. Then the assessed valuation of the county would be $4,800,000.00 and under a state and county aid law, the cost of hard roads is divided into three equal parts, charging same to state, county and township. The state's portion of the cost would be paid in cash from the one mill tax levy; the county and township would pay their portions by issuing bonds payable in twenty annual installments, with 3½ or 4% interest. To meet these bonds with the interest, the county and township must each raise upon an average of $1200.00 per year for twenty years. The township tax must be spread over $300,000.00 valuation, which will make the rate four mills; the county tax must be spread over $4,800,000.00 valuation, which makes the county tax one-fourth mill; so upon the farm in question the annual tax will be state tax $1.80, county tax $0.45, township tax $7.20, a total of $9.45.

The above is based upon only one of the sixteen townships in the county building hard roads; for every other township where $60,000.00 is expended for hard roads, the county tax will be increased one quarter of a mill, equal to $0.45 per quarter section, which would have to be added to the above. If every township in the county should undertake at once the building of a similar system of roads, the county tax on the farm would be four mills or $7.20, which with $7.20 for township and $1.80 for state tax would bring the total up to $16.20. This would represent the extreme limit and would give about two hundred and fifty miles of hard roads in a county twenty-four miles square, which is really more than will usually be necessary. Probably a hundred and fifty miles will serve the purpose fairly well; if so, the county tax will probably not exceed $4.00 or $4.50 for the quarter section, which would make the total tax for hard roads $13.00 or $14.00, or less than ten cents per acre for twenty years, when the roads would be paid for.

Suppose the farm in question is planted in corn and yields an average of forty bushels to the acre; the tax then will represent ¼ of a cent a bushel on the crop. Experience shows, and surely every one will admit that a wide-awake farmer having at all seasons of the year good hard roads, can, by watching the markets and selling his corn under the most favorable conditions, get at least one cent a bushel more than he can under present conditions. With hard roads he can take advantage of the markets—with mud roads the markets often take advantage of him—and he can save the cost of hard roads many times over every year.

The building of hard roads on the main thoroughfares will reduce the present road and bridge tax at least one-half, so the cost of hard roads is so evenly distributed that it does not become a burden.

Usually fifteen or at most eighteen miles will cover the main roads in any township; these can be macadamized or graveled, making a permanent hard road at a cost not exceeding $60,000.00 in any part of the state and usually for $50,000.00. In localities having material close at hand, the expense can be cut to $35,000.00 or $40,000.00. With modern road machinery the remaining dirt roads can be graded, crowned and drained, greatly improving them and the whole cost will not increase the present road tax over ten cents per acre per year. The whole question is, are hard roads and good roads worth $16.00 per year for a quarter section of twenty years?

Generally the cheapest and most accessible material could be used. In about half the state gravel can be had; in the southern part of the state a very good material known as novaculite is found; in the vicinity of Joliet and Chicago there is an abundance of all road material, gravel, lime stone and furnace slag, the latter being one of the best and cheapest materials known. Chicago's great drainage canal has upon its banks millions of cubic yards of good road material.

The railways are benefited by hard roads every day in the year and it is almost as much to their interest to have them built as to the farmer. Under direction from Washington, a special agent of the Department of Agriculture took up the question of transporting road material with the Presidents of ten of the leading railways of Illinois. In every case they expressed their willingness to haul road material for this purpose at actual cost. One President said: "We will haul it on any terms required and if the cost isn't low enough, the farmers may fix the tariff." This attitude makes it possible to build hard roads at low cost in any part of the state.

There are many other very important results than those given to be had from good roads. The children in the country must get their education principally during the bad road season, November to April; with hard roads, the smaller children need not stay out; all can go on the rainiest days. Better schools will result from more uniform attendance.

Good roads make the township high school practicable; no other influence will do so much for education in the country as good hard roads every day in the year.

The federal census, now nearing completion, shows with increased emphasis what has been the striking fact in every enumeration taken since 1870; this is the remarkable increase in the population of great cities as compared with the increase in the rural district. The cities have levied a heavy tribute on the country and have, with increased numbers as the years have gone by, drawn much of the best blood from the farms, until to-day a very large percentage of the business and professional men in the great cities are farm bred and born. The cause of this is not far to seek. The youth of the farm dreams and longs for the intenser life of the city. He feels an almost irresistible desire to get close to the nerve centers. He is not content to be shut in and mud bound for weeks and months at a time. The question of the hour is "How to keep the boys on the farm." The answer is that they be put in contact with the world.

Country life demands, and must speedily have, free rural mail deliveries and the daily paper delivered on the date of publication. It demands a telephone; it demands above everything else a complete system of good hard every-day-in-the-year roads. They make country life better worth living, they broaden education.

Under the census of 1870 one person lived in Chicago for every eight and a half persons in the state; in 1880 one person in Chicago for five persons in the state; in 1890 one person in Chicago for two and a half persons in the state; in 1900 the returns show one person in Chicago for 1.8 person in the state. If this increase of growth continues in the city, in ten years Chicago will out vote the balance of the state and dominate it politically; this would be a misfortune for both the state and the country. Good roads serve to distribute the population, bad roads to congest it.

To summarize some of the advantages of good roads: A farmer living four miles from town can haul four heavy loads per team per day; his son or daughter goes to town, often reaching it in thirty minutes on a bicycle; he can get the doctor out in half the time that he can at present; should he break down at harvest or threshing time he can go in, get repairs and get back in half the time this requires now; if he desires to go to church he can do so in comfort every day in the year; when it is too wet to work in the field the hired man can haul grain or stock to the market; distance is no longer measured by the yard stick, but by the clock's tick. Good roads cut every mile in two. With good roads the steep hard hills will be cut down, the low places filled up, and easy grades established. Driving on good roads is a pleasure and not a task. Good roads make farm life worth living.

The maintenance of the roads after they are built must be carefully looked after. Under the law now proposed they would be gone over every thirty days, and would be under the supervision of some one who is responsible and who sees that work is done properly and at the proper time. In Austria the roads are taken care of by the national government and by districts. In Italy it is the same. In Denmark they are under the control of the state engineer. The roads of Belgium are under the local authorities. In the Netherlands they are maintained by the general government. In Switzerland the government has few roads, most of them are controlled by the canton.

MR. J. H. BURNHAM: The speaker has worked in the interest of good roads for the last twenty-five years. His business has brought him in contact with many Highway Commissioners and he is well acquainted with road work. It is unjust to say that taxes paid in labor are wasted. This may occur in few places but is exceptional. It is a fact that townships in which all the road tax is paid in labor often have better roads than adjacent townships in which the tax is paid in cash. Many farmers contribute a great deal more than their taxes to put roads in good condition; it is the custom of public spirited farmers to make donations for the good of roads.

The matter of state aid in building permanent roads should be looked into. The people of the cities seem to be willing to give aid and some system should be devised by which they are taxed as much as possible. The time is coming when the cities must do a great deal. There are twenty-four counties in the state which are miserably poor, so poor that they are allowed a levy of only 25 cents on $100.00 assessed valuation. This is not enough to provide for the enforcement of laws, let alone improvements, and some plan should be devised by which the wealthier portions of the state may help these poorer counties.

HARD ROADS OF McLEAN COUNTY, ILLS.

BY A. H. BELL.

McLean is probably not a pioneer county on the question of hard roads, but it has made a beginning and some experience has been gained which may be of value in other sections of the country situated under similar conditions. Note must be taken of the statement "under similar conditions," because circumstances in the various sections of the country modify the requirements to such a radical extent, that what might be a decided success in one place, might be too expensive or impractical elsewhere.

Nature of the Soil. The soil over which roads or highways have to be built in McLean County is either of the nature of a black loam or yellow clay, the former predominating. As is well known either of the above soils will readily become soft and yielding under the influence of frost and water.

Roads Built. So far as the author is aware there are but three townships in McLean County that have made any material progress in the construction of hard roads: (1) Lexington township, in which is situated the town or village of Lexington; (2) Cheney's Grove Township, in which is situated the town of Saybrook, and (3) Bloomington Township. There are probably some other isolated stretches of hard road in the other townships, but they are of small magnitude and of the same general construction as those hereinafter described. They will be considered in the general order above enumerated.

The information concerning these roads was obtained from the road commissioners along with personal observation of and inspection by the author.

(1) *Lexington Township.* Lexington Township, lying about 15 miles northeast of Bloomington, has about 22 miles of gravel roads which radiate in the cardinal directions of the compass from the town of Lexington.

The roads are constructed under the supervision of the Highway Commissioners of whom there are three in each township. The general construction is as follows: The gravel is hauled by teams from the bank and deposited in a width of about 12 feet. When spread out and leveled off, this makes a road-bed 15 or 16 feet in width and 10 to 12 inches in depth at the center. About five loads of gravel are required to the rod in length having the above cross section. The cost of building the gravel road is, of course, more or less regulated by the proximity of the gravel bed. Roads constructed during the past year cost on an average about $1200 a mile. The haul was about three miles, the cost of hauling being 60 cents per cubic yard. The cost of the gravel was 10 cents per cubic yard at the bank. In a general way, the gravel roads of Lexington Township cost from $1000 to $1500 per mile, depending upon the proximity of the gravel pit. The author's understanding is, that the items of tiling and grading do not enter into this estimate, as this has generally been done, where it was deemed necessary, in previous years.

The roads are pretty generally graded up by the road grader, and no special grading is done as a preparation for the gravel. The general practice is to place the gravel road rather to one side of the highway, thus leaving a dirt road to be used when in proper condition. It is possible to use this dirt road during a very large portion of the year. This is a very essential and important feature of gravel road construction in McLean County.

The oldest gravel road in Lexington Township has been in use about 16 years and is still in good condition. As to maintenance and repairs of the gravel roads in McLean County, it is necessary to do some repairing each year. A few loads of gravel are put in where depressions develop; but the expense of maintenance is very small and much less than in the ordinary dirt road.

There is a special tax levy in this township for building hard roads of, from 20 cents to 60 cents per hundred dollars. Gravel is to be had in abundance in this township.

(2) *Cheney's Grove Township.* This Township is said to have about 7¼ miles of gravel road. The gravel is first laid about 8 feet wide and 14 inches deep, requiring about 5 yards to the rod. The cost of hauling and distributing the gravel is given at 33⅓ cents per cubic yard or load, the material costing 5 cents per yard at the bank and the haul averaging about 1½ miles. This would make the road cost about $600 per mile. No special tax levy is made for hard roads in this township but as much road is built each year as possible from the Special Road and Bridge tax. The oldest gravel road in Cheney's Grove Township has been in use about 14 years and is still giving good service. Where the width of the highway will permit, the gravel bed is placed to one side of the road, leaving the dirt road for seasonable weather.

(3) *Bloomington Township.* Bloomington Township, the wealthiest in the county, has but recently experimented with the hard road question. This is probably due largely to the fact that gravel in this township is difficult to obtain. However, recently an appropriation of $21,800 was voted by the township to apply to the construction of hard roads. It was contemplated to build three miles leading west from the city limits of Bloomington on what is known as West Washington St.; also three miles leading south on South Main St. Owing to the amount of grading and the expensive material, the amount appropriated was sufficient only, to construct two miles west of the city and about 1.37 miles south of the city, making a total of 3.37 miles. The cost of construction, the author is informed, exceeded the appropriation by about $1195, making a total cost of $22,995, or about $6823 per mile. The grading and tiling in the roads cost approximately $4500. The material used for the road bed, was Novaculite, or Elco gravel, from the vicinity of Cairo, Ills. A distinct channel was formed in the road, 12 feet wide

and 8 inches deep, in which the Novaculite was placed. It was rolled with a six ton roller. The cost of the Novaculite was 75 cents per square yard laid down.

As to the merits of Novaculite for hard roads on the soil described, there is at this time much diversity of opinion. The short time it has been down does not justify either condemning or recommending it. The author, however, has had considerable experience with the material in Cairo and suburbs and can, therefore, speak from some personal observation. Where the road bed is kept clean from mud it proves a very satisfactory and durable article. The top surface grinds into a dust, which upon the application of water or rain, has the property of cementing and becoming very compact and hard, also quite smooth. But if mud is allowed to accumulate on it, or teams come on it from mud roads, it will "pick up" and become full of holes and sinks, even more so than macadam. This is especially the case when the pavement is of recent construction and has not become thoroughly compacted and solidified. The writer does not regard Novaculite as much superior to a good quality of gravel for hard roads in the locality of McLean County. What there is has been laid at great expense, and it is hoped that it will prove a great success. Its great cost, however, will preclude its further use in this locality.

The gravel roads as described in the two townships above are a success and give universal satisfaction. This is proved by the fact that more miles of gravel roads are being added each year in the townships quoted, which is an endorsement beyond question.

The method of construction of gravel roads in McLean County has been somewhat primitive, no doubt, and in all respects an air of economy has pervaded the minds of the Highway Commissioners. The author is not aware of the services of an Engineer being engaged in their construction, either in tiling or preparation of the road bed. There is no doubt but that the services of a good practical and experienced Engineer would add to their general benefit and very materially to their sightly appearance; but the Highway Commissioners are generally selected from the farming community and they only employ a surveyor or engineer as they do a doctor or lawyer, i. e. in self-defense. This will change with time and education.

Certain facts seem to have become established from the experience of building gravel roads in McLean County. First, they are a success from a financial and economical standpoint, affording a very satisfactory means of transportation at any and all seasons of the year. They enable the farmer to deliver the products of his farm to the highest market afforded, and they reduce very materially the annual expense of the road grader and other repairs on the common dirt road. Second, gravel has proven so far the most desirable material for a road bed in this locality. Third, the gravel bed should be laid to one side of the road. Fourth, the road bed should be thoroughly tiled or drained before laying gravel. Fifth, the quality of gravel giving the best results is a clean gravel (free from mud or clay) with about 25 per cent. of sand to act as a binder; in general, this gravel should not exceed one inch in diameter. Sixth, the cost of maintenance is very light when properly constructed.

DISCUSSION.

MR. W. A. HAY: The roads have so far all been built by farmers, there being no engineering supervision. If work were done under a state engineer, assisted by local engineers, better roads would result.

The matter of grades on the roads is important; they should be cut down to some practical limit which would greatly increase the size of load that could be hauled.

MR. H. H. GROSS: The bill now before the legislature contemplates a state engineer and resident engineer in charge of work. When the roads are once built under this supervision, the cost of maintenance will be very small.

MR. J. A. HARMAN: The Novaculite pavement in Peoria has given various results. One block picked up considerably and another was very good. It is a good pavement for resident streets.

MR. J. G. MELLUISH: The Novaculite is no different from any other crushed stone; if it is muddy it will pick up. This indicates the precaution which must be used with Novaculite pavement. On the road near Bloomington, paved with this material, a size of stone known as No. 3 was used, this will pass through a three quarter inch sieve. It is preferable to the finer for a binder, and gives a smooth surface; although it will absorb more or less moisture which will cause it to pick up from freezing and thawing.

MODERN BRICK PAVEMENTS.

BY W. H. TARRANT.

The early brick pavements of this country were, to a large extent, failures because of a lack of knowledge of the requirements of a durable brick pavement, and the inferior quality of materials available at that time. The first brick pavement which was constructed in the United States was at Charleston, W. Va., in 1872. This pavement had a foundation of three inches of gravel, well rolled; on this was laid inch boards dipped in coal tar, upon which was placed an inch and one-half sand cushion. The top course consisted of common red brick laid on edge, herring bone fashion with sand filler. This pavement did not give good results, and in a few years was beyond repair.

The next effort to secure a durable pavement was the common two-course pavement which we see in so many of our cities to-day. The earlier pavements of this class gave scarcely any better results than the Charleston pavement, owing to the inferior materials and construction.

A few years ago the construction of brick pavements with a concrete foundation was commenced. By rigid requirements in the specifications, and the desire of the brick manufacturers to make more durable brick, there have been produced brick pavements in this country which are the best in the world.

The object of this paper is to give a few of the many requirements of a brick pavement with a broken stone concrete foundation, concrete curb and gutter, and one course of brick. This kind of pavement is the only one which will give satisfactory results. The writer will place the subject of construction under the following heads:

1. Connections, gas, water, etc.
2. Sub-grade.
3. Crown of street.
4. Concrete curb and gutter.
5. Concrete foundation.
6. Sand cushion.
7. Laying and rolling the brick.
8. Filling the interstices between the brick.

1. When an ordinance is passed for the paving of a street, notice should be given the property owners along the line of the proposed improvement to make the necessary gas, water, sewer and drain connections to their premises. In case this notice is not complied with by the property owner, the city should make the connections and when they are used, the actual cost with interest should be charged to the owner. All connections should be made under the direction of the City Engineer or his assistants and should be made in a satisfactory manner. If, by reason of neglect or oversight, the private connections are not made until the pavement is completed and the connections are then desired, application should be made to the City Clerk and an amount deposited sufficient to make the desired connection, concrete the trench, and relay the pavement. The work should be done by the City, and if the amount deposited is larger than the actual cost of connection, the balance should be rebated to the applicant.

If, at any time, the city authorities grant a franchise or privilege to any company or corporation which necessitates the tearing up of the pavement to lay gas, water, or any other mains or conduits there should be stipulated in the franchise certain requirements, First, all surplus should be removed from the trenches. Second, after the mains are properly laid, the trench must be filled with broken stone or gravel concrete to the required depth. Third, in case this is not done, the trench must be filled with cinders, gravel or, preferably, well tamped clay to within eighteen inches of the top of the concrete foundation; then removing from the sides of the trench, commencing at the sub-grade and running outward at an angle of thirty degrees, enough soil to make a ledge of six inches on either side of the trench; completing the filling with gravel or broken stone concrete upon which the pavement is to be relaid. If the various connections are completed before the awarding of the contract, there can be no delay to the contractor by reason of connections along the line of the work.

2. The grading should be done in the following manner: Where excavation is necessary, no plow should be used within three inches of the finished sub-grade. The remaining excavation should be dressed off with hand tools. Where filling is necessary, it should be done in layers of not more than four inches, each layer well dampened and rolled. All soft or spongey places should be removed and filled with gravel well rolled. The surface after being brought to sub-grade (with allowance for rolling) should be thoroughly rolled with a roller at least five feet in width and weighing not less than two hundred and fifty pounds per inch in width. After the sub-grade is thoroughly rolled and ready for the concrete foundation, no loaded or empty wagons or other vehicles should be permitted on the subgrade, unless it be protected by a covering of boards. All paving material should be placed along the line of the proposed improvement before the completion of the sub-grade.

3. The cross section of the street should be parabolic in form with the vertex of the parabola in the middle of the street. In the practice of the writer, the following formula has been used with excellent results: $C = .014\,w \times .03$, where C is crown of street, and w the width of street in feet. The constant .03 of a foot is added to the middle ordinate of the street, so as to slightly elevate the center and thus avoid a flattened place in the street, and to secure better drainage and a cleaner street.

4. For the residence portion of a city, there is no one feature of a brick pavement which adds more to the pleasing appearance of the street than a concrete curb and gutter and when properly constructed, and first class materials are used, it will be as durable as any other portion of the pavement. The gutter should have a width of eighteen inches and a thickness of six inches, and the curb a thickness of five inches, for a street having a width of thirty-six feet. The gutter should have a slope of one inch towards the curb. The height of the curb above the gutter should be seven inches. The upper face edge and juncture of the curb and gutter should have a radius of one and one-quarter inches, and the construction should be such as to make the curb and gutter one solid mass.

The foundation should be six inches of gravel or cinders, well dampened, and thoroughly tamped with a tamper having an area of not less than thirty-six inches and weighing not less than thirty pounds. The concrete portion of the curb and gutter should consist of one part Portland cement and five parts clean gravel. The cement and gravel should be thoroughly mixed dry, then water added until the mass is a little more than moist, then placed in forms and well tamped with a tamper as described for the foundation. The author is of the opinion that the secret of a first class concrete curb and gutter is to have the concrete well tamped. The finish coat should be one inch in thickness and consist of one part of Portland cement and one and one-half parts of clean sharp sand. The finish coat should be placed on the concrete before the concrete has begun to set and thoroughly troweled, so as to give a perfect bond between the two. If this precaution is taken, there need be no fear of hollow blocks. The concrete curb and gutter should be made in alternate sections, and in lengths of seven feet.

The finished curb and gutter should be protected from the sun and wind by a covering of canvas, for at least twenty-four hours. In extremely dry weather the curb and gutter should be sprinkled at least once a day for three or four days. The catch basin inlets should be built in the curbs. The best form of inlet is the corner inlet with vertical bars, this inlet will never become clogged by leaves or rubbish on the street.

5. One of the most important parts of a durable brick pavement is the concrete foundation or sub-structure for the brick. This is one portion of the pavement which, in many instances, is neglected and one which should have the greatest care. One of the primary elements of a first class foundation is to have a perfect sub-grade upon which to lay the concrete.

The concrete should be composed of one part of American natural hydraulic cement, two parts clean sharp sand and four parts of broken stone. If Portland cement is used instead of the Natural cement, the proportion should be one of cement, three of sand and six of broken stone, or if the gravel is used instead of the broken stone, one of Portland cement to eight of gravel. Recent experiments with the broken stone concrete and gravel concrete (using the Natural cement in the broken stone concrete and the Portland cement in the gravel concrete) the gravel concrete gave an increase of strength of 30 to 50% over the broken stone concrete. The thickness of the concrete foundation should be six inches, and under all street car tracks the concrete should have a depth of six inches below the bottom of the ties. The sand and cement should be thoroughly mixed dry until the mass has a uniform color, and then enough water to give it the proper consistency. The broken stone is then to be added, and the mass turned three times and then shoveled into the work.

To give the surface of the concrete foundation the proper crown, the best method is to set a line of stakes along the center of the street about three feet apart, then by means of a templet with one end on the center stakes and the other end on the curb, set a line of stakes perpendicular to the curb line and about three feet apart, driving the stakes to the exact surface of the finished concrete. By this method the grader has ample opportunity to bring the surface to a perfect grade.

One of the most important matters in making the concrete foundation, and one which is very often neglected, is the tamping of the concrete. The concrete should be tamped with a tamper weighing not less than thirty pounds and having an area of not more than twenty-five square inches. It should be thoroughly done. After it is sufficiently tamped with the iron tamper and any hollow places appear, they should be filled with cement mortar and again tamped with an oak tamper about eighteen inches square. The surface of the concrete should then be parallel to the surface of the finished pavement. Much depends upon this, and if not done, the pavement, when completed, will be flat in places and have a wavy appearance. After the concrete has set a few hours it should be covered with a half-inch of clean moist sand. In extremely dry and hot days it should be sprinkled a few times each day until the bricks are laid.

6. The sand cushion should be of clean dry sand and have a thickness of one and one-quarter inches. It should be graded by means of a templet having the exact contour of the street. It should be so constructed that one end of the templet will rest on strips in the center of the street and the other end on the curb. The sand at all times should be perfectly dry, and under no other condition should the cushion be luted.

7. The bricks should be laid in rows perpendicular to the curb, except at street intersections where they should be laid at an angle of forty-five degrees. Bats should be used only in commencing the rows and making the closures, and should be used in no other place. The brick should be laid with the least possible space between them. Wheeling on the pavement should be done on boards and the brick should be dumped from the barrows in the direction of the rows. After the brick are laid they should be carefully inspected. All chipped brick should be turned, the soft and defective ones should be thrown out and replaced with good ones.

The best method of laying brick between street car tracks is to lay them parallel to the rails. One row on the outside of the rails should also be laid parallel to the rail. This row gives the trackmen a chance to tighten up the bolts or drive spikes without molesting more than one row. The first row on the inside should be laid flat when a six inch "T" rail is used. The remaining rows are laid on edge and if the three and three eights inch brick are used no cutting is necessary.

The rolling of the brick should be done parallel to the curb commencing at the center and rolling towards the outside. It should be done with a roller weighing not less than two hundred pounds per inch in width. The pavement should be rolled at least three times. After the rolling is done the brick should have their final inspection and all broken or chipped brick removed, and replaced by good brick.

8. If the brick are standard brick and not repressed, sand makes the best filler, but if they are repressed brick, the Portland cement grout should be used. If the manufacturers of paving brick would discontinue the use of the repress machine we would have a better quality of brick. The repressing of the brick destroys the bond which is given the clay when it comes from the brick machine and the repress machine does not put enough pressure on the brick to make a new bond. The result is that after the brick are burned and placed in the street they scale off on the edges. In the standard brick the bond is not broken and the brick do not scale or chip in the street.

If the sand filler is used the sand should be clean, sharp, dry, and fine. The sand should be placed on the street in thin layers and thoroughly broomed into the joints with steel brooms. When the interstices of the pavement are all filled a half inch of sand should be left on the pavement.

If the grout filler is used it should consist of one part of Portland cement and one part of clean, sharp sand. The cement and sand should be thoroughly mixed dry in a tight box about two and one half feet wide and about four feet long. Water should be added until the mass has the consistency of thick cream, then it may be poured on the pavement and broomed into the joints. It should be applied in two courses, the second course be mixed a little thicker than the first. When the joints are well filled and the cement is allowed to set for a few hours, a coat of sand should be placed over the pavement to protect the grout from the wind and sun. The grout should be allowed to set from seven to ten days before the traffic is turned on the street.

In the preceding paragraphs the author has to some extent discussed a few of the many requirements of a durable brick pavement, but no mention has been made of the quality of the materials, one of the most important elements of a first class pavement. The City Engineer who has not the apparatus to test all the materials which are put in the pavement, has the sympathy of all lovers of first class work.

Cement. The cement which is used in the construction of the pavement should be thoroughly tested. There are at present so many different brands of cement on the market and so many different grades, that if it is not tested, the chances are that an inferior quality of cement will be used. The cement should be the best quality hydraulic cement.

The contractor should notify the Engineer of the arrival of the cement and samples should be secured by the Engineer or his assistants. Not less than ten samples should be secured from each car. The cement should be tested for soundness by mixing up three pats, which are placed in water after the cement has its initial set. If the cement shows cracks, contortions, or discoloration it should be rejected. The initial and final set should be determined. For Portland cement, the initial set should be not less than thirty minutes, nor more than one hour, and for natural cement not less than ten nor more than thirty minutes. The final set for Portland should be from two to six hours and for Natural cement from thirty minutes to one hour.

The cement should be evenly ground and when tested with the following standard sieves, should pass at least the following percentages:

	Natural	Portland.
No. 20 sieve, having 20 meshes per lineal inch	100%	100%
No. 50 sieve, having 50 meshes per lineal inch	90%	98%
No. 74 sieve, having 74 meshes per lineal inch	80%	95%
No. 100 sieve, having 100 meshes per lineal inch	....	90%

The diameter of wire for the sieves being respectively Nos. 28, 35, 37, and 40 Stubs' wire gauge.

The required tensile strength for American natural hydraulic cement should be as follows:

Neat Cement:

One day, till set in air, remainder of time in water	60 lbs
Seven days, one day in air, six days in water	150 "
Thirty days, one day in air, twenty-nine days in water	275 "

Cement one part, sand one and one half parts:

Seven days, one day in air, six in water	50 lbs
Thirty days, one day in air, twenty-nine in water	100 "

The required tensile strength for Portland cement should be as follows:

Neat Cement:

One day till set in air, remainder of time in water	175 lbs
Seven days, one day in air, six in water	500 "
Thirty days, one day in air, twenty-nine in water	650 "

Cement one part, sand three parts:

Seven days, one day in air, six in water	100 lbs
Thirty days, one day in air, twenty-nine in water	175 "

Brick. The brick should be straight, regular in size and shape, and free from flaws or cracks. They should be expressly made for paving purposes and should be hard and tough and thoroughly vitrified, and should fill the following requirements:

The modulus of rupture for transverse strength must be not less than two thousand (2,000) pounds per square inch, computed by the formula:

$$R=\frac{3Pl^2}{2bd^2}$$

in which R is the modulus of rupture in pounds per square inch, P the load in pounds, l the length, b the breadth, and d the depth, all dimensions being in inches.

The brick should not absorb more than four (4) per cent. of their weight of water after being broken and immersed for forty-eight (48) hours.

The abrasion test should be made by placing not more than twelve bricks in a rattler twenty-four (24) inches in diameter by thirty (30) inches long, together with one hundred and seventy-five (175) pounds of eight pound shot and one hundred and seventy-five (175) pounds of one pound shot. The shot will be of cast iron, the eight pound being 2½"x3⅛"x5¼", with edges rounded to a one half inch radius, and the one pound being 1"x1½"x2½", with rounded edges. The rattler will then be revolved one thousand (1000) revolutions at a speed of between twenty and thirty revolutions per minute. The loss of weight at the end of the test should not be more than twelve per cent.

In conclusion the author would suggest that the contract be awarded to a reliable contractor, one who will do a perfect job and has the reputation of doing good work. An inspector should be secured who has a perfect knowledge of the construction and one who can be relied upon; not the political inspector who secures his job by reason of his "pull". Close attention should be paid to the little details of the work, as this is one of the secrets of a perfect job. If the best materials and workmanship are secured, there need be no fear of inferior brick pavements.

DISCUSSION.

THE ADVANTAGES AND VALUES OF FILLERS FOR BRICK PAVEMENTS.

PROF. I. O. BAKER: The speaker believes that this is an appropriate question. In the East different kinds of fillers are used. In Ohio it is customary to use a filler other than sand, while in Illinois and Iowa, sand is the common one. Sand is the cheapest, but it is not so good as grout and cement, which will cost about ten cents per square yard. If grout and cement filler were used in this locality the edges of the brick would not chip. Sand is lifted out of the joints, leaving the edges of the brick unprotected.

PROF. A. N. TALBOT: The speaker's opinion has changed somewhat in the last two or three years and he is growing more favorable to the advantages of cement filler. It does protect the edges of the brick and is not lifted out. It also holds the brick tightly together and prevents them from rolling. It is common to find that the bricks are a little bit loose and cement filler would have an advantage, especially on a steep grade and where traffic is heavy. In Indiana cities and in one city in Illinois cement filler has been used and it is reported that it adds several years to the life of the pavement.

An ordinary mixture of Portland cement is as valuable as any patent filler.

MR. H. G. PADDOCK: In Moline and Rock Island there are steep grades over which there is a great deal of traffic. Sand filler is used almost exclusively. There has been no trouble from brick rolling, unless it occurred before they were compacted. Cement filler has been used in the gutters to prevent washing.

Engineers should be careful in the use of patent fillers; they should not recommend them until they are sure that they are worth the extra cost.

MR. H. E. BEASLEY: The matter of lifting the filler out of the joints has been referred to. If a suction sweeper is used this will surely occur when the filler is not firm. There is no doubt that if the chipping of the brick can be prevented, the life of the pavement may be doubled. In Minneapolis a cement grout has been used and is giving satisfaction. The cost is nominal and if five or six years are added to the life of the pavement there is a great advantage.

MR. W. H. TARRANT: Great injury often results to brick in the process of manufacture. They are pressed to make them smooth; the bond is destroyed by this, not enough pressure being used to form a new bond. If only standard brick were used there would not be so much chipping; however, this can, to a great extent, be prevented by a grout filler.

REPORT OF COMMITTEE ON ROADS AND PAVEMENTS.

To the Members of the Illinois Society of Engineers and Surveyors:

GENTLEMEN: Your Committee on Roads and Pavements beg leave to make the following report:

In the past year but few counties in the state have constructed permanent hard roads. In McLean County the largest amount of permanent roads was constructed. In a few of our cities macadamized roads have been built. Throughout the state meetings have been held to discuss the road question. In all the meetings there was a lack of knowledge of the means and methods of securing permanent roads. The method of assessing the expense of building permanent roads is a problem which is discussed quite freely. Some advocate the county paying for the improvement, others the state, and some the property along the line of the proposed improvement. There is at present an effort being made by the hard road advocates to have the legislature, at the present session, appropriate a certain sum for the permanent improvement of the public roads.

The most serious problem which confronts the hard road advocates is the obtaining of material to construct them. In the central and western parts of the state no material is available. In case the material can be found the transportation charges are so exhorbitant that it is impossible to use it.

In each township of the state the Highway Commissioners levy on an average sixty cents per year per One Hundred Dollars assessed valuation. Half of this sum is expended on permanent bridges, the balance is practically wasted by the method of allowing the property owners to work out a portion of their tax. The road and bridge tax should be expended judiciously in such improvements as steel bridges and thoroughly draining the roads, and thus prepare the roads for permanent improvements.

In the past year brick pavements have, to a large extent, been constructed in the larger cities. In this state there are a large number of small cities which have no pavements and have never realized the value of a first class pavement. One of the conditions which makes it more difficult for the smaller cities to pave, is the amendment to the Board of Local Improvement act, which was passed in 1899. This puts a restriction on cities of less than ten thousand inhabitants by the clause, "no ordinance for making any improvement shall be adopted unless a majority of the resident property owners affected by such improvement shall petition for the same." It is difficult to secure the frontage on a street in many cases, without counting the names to see if the majority of the property owners have signed the petition. This clause in the law practically blocks all public improvements in drainage or sewer districts.

The restriction in the recent law should be repealed by an emergency clause at the present session of the legislature and give the cities of less than ten thousand inhabitants the same privileges as the larger cities.

W. H. TARRANT, Chairman.

DISCUSSION.

MR. J. H. BURNHAM: The law allows a levy of 50 cents per hundred dollars assessed valuation. Some townships make this levy in cash, others in labor; it ranges from 60 to 80 cents. A division is sometimes made, 20 to 40 cents being payable in labor and 15 to 40 cents in cash.

The author infers from the statement of the committee that but few counties have constructed hard roads, that they refer to work done under the hard road law. That is true yet many counties —Kankakee, Grundy, Kane, and Lake, for example—have built a number of miles out of the regular road tax.

REPORT OF THE COMMITTEE ON PAVING BRICK TESTS AND SPECIFICATIONS.

To the Members of the Illinois Society of Engineers and Surveyors:

GENTLEMEN: At the Moline meeting of the Society, the Committee on Paving Brick Tests and Specifications was instructed to find whether the Office of Public Road Inquiries of the United States Department of Agriculture would undertake an investigation of methods of testing paving brick. In answer to the inquiry, the Director replied that it would be impossible at this time to test materials for city streets. Materials for the construction of country roads will be tested. It seems impracticable to secure an investigation of tests of materials for city streets in this way.

For some years the Committee on Paving Brick Tests and Specifications has been working to secure the general adoption of some method of testing paving brick which would be fair, discriminating, and easily made uniform in different parts of the country. It has favored some form of shot test as being the best available method, and has strenuously objected to the method adopted by the National Brick Manufacturers' Association in 1897 wherein brick themselves formed the only tumbling or abrasive material in the rattler; on the ground that this method was not certain to distinguish soft and brittle brick. Various experimenters criticised the N. B. M. A. method, and considerable dissatisfaction arose in several of the cities where this method had been adopted. These criticisms finally resulted in a further investigation of the question by the Committee on Technical Investigation of the National Brick Manufacturers' Association, which also included tests of the Jones rattler in which brick are clamped in pockets around the periphery of the rattler and cast iron cubes are used as the abrasive agent. This investigation was made by Prof. Edward Orton, Jr., of Ohio State University, who had been in charge of the experimental work in 1895-7. The tests were made upon seven makes of brick of three grades each, hard, medium and soft. Between 4000 and 5000 bricks were used in the investigation which was completed in January 1900.

Upon the completion of this work, the president of the National Brick Manufacturers' Association appointed a committee of seven to receive and consider Professor Orton's report and to make recommendations to the Association. Manufacturers, engineers, and investigators were represented on this committee. Its personnel was as follows:

Prof. J. B. Johnson, Dean of College of Engineering of the University of Wisconsin, chairman; Prof. A. N. Talbot, of University of Illinois, secretary; Mr. H. A. Wheeler, St. Louis, Mo.; Mr. Gomer Jones, Geneva, N. Y.; Mr. D. V. Purington, Chicago, Ill.; Mr. J. H. Higley, Canton, O.; Prof. Edward Orton, Jr., Columbus, O.

This committee met in Chicago Jan. 27, 1900, and reviewed the large amount of data submitted by Prof. Orton and by other members of the committee. They decided to recommend that the standard rattler method of testing paving brick, adopted by the Association, be amended by striking out the provision requiring the use of brick alone in the rattler. A substitution was recommended of a charge of 300 lbs. of standard shot, one fourth of which to be of 7½-lb. size and three fourths of 1-lb. size (roughly) with twelve paving bricks or nine paving blocks. They further recommended that the brick should be thoroughly dried before rattling, and that further investigation of rattlers of the Jones type be made.

The Detroit convention of the National Brick Manufacturers' Association adopted the report of the committee and thus abandoned the method criticised by this Society and accepted the general method here proposed.

An outline of some of the results brought out in this investigation may be of interest.

A considerable investigation had first to be made which may be termed the calibration and standardization of the three processes, the old N. B. M. A. standard, the shot method, known as the Talbot or University of Illinois standard, and the method with the Jones rattler. This investigation determined the effect of change of speed, amount and nature of the charge, number of brick tested, necessary duration of test, effect of the test in chipping and abrasion, etc. These preliminary tests involved a great deal of time and labor.

After standardizing the processes, tests were made by each process on three grades of each of the seven makes of brick. The three grades of brick were so distinctly different that a skilled observer would readily distinguish them, and the individual brick of each grade were nearly enough uniform in character, that the average of a lot selected for one machine would not vary far from the average of those used with another machine. The three grades, except for the makes which were not intended to be pavers, were selected as (a), well-burned No. 1 pavers; (b), under-burned No. 2 pavers; and (c), soft-burned, fit only for building purposes. For one make, the No. 2 grade was but slightly inferior to the No. 1, but generally the inferiority was fairly well marked.

On the matter of detecting the inferior brick, the old N. B. M. A. standard failed to select the best brick in three out of the seven makes. The Jones process failed in one out of seven. The shot method distinguished the best brick in every case. In comparing the clearness with which these three tests distinguished the superior from the inferior brick, it was shown that the Jones process indicated the relative hardness of the three grades of brick somewhat more markedly than did the others in four out of the seven makes, while the shot test excelled in three. The Jones machine failed to detect the structural weakness of the brick, but its most objectionable feature was, that it was extremely defective in its comparison of the brick size and the block size; the loss for the brick size being two and a half times as great as for the block size with bricks and block made of the same material in the same kiln and under as near the same conditions as could be obtained. These defects, as well as defects in the machine, caused it to be rejected in the present form. The investigation also showed that the shot test brings out structural defects of the brick and that the range of results are fairly close to its averages.

The Illinois Society of Engineers and Surveyors has favored the adoption of a standard form of rattler test, and the time now seems opportune for such action. It is appreciated that the rattler method is not perfect, and that a much better machine may yet be devised. The adoption of a standard method need not bar amendment when it is shown that a new process is superior to the present form. The action of the National Brick Manufacturers' Association, in revising the objectionable features of their method, has removed the greatest obstacle in the way of the general adoption of a standard method. In view of the desirability of uniformity and recognizing that any such standard method may require revision in the future, the following regulations for a standard method of conducting the rattler test for paving brick are presented, and the committee recommends that the Society accept them as a standard method and recommend their adoption by engineers.

STANDARD METHOD OF CONDUCTING THE RATTLER TEST FOR PAVING BRICKS.

1. *Standard Rattler.* The standard rattler shall be polygonal in cross section, with 14 plane staves spaced one-fourth inch apart at their edges, and the interior shall be free from projections, offsets, roughnesses, or obstructions. Rattlers having two staves more or less than the standard number may be used. The internal dimensions shall be 28 inches in diameter and 20 inches in length.

2. *Standard Shot.* A mixture of two sizes of shot will be used. The larger size will be about 2½ inches square and 4½ long and will weigh about 7½ pounds. The smaller size will be 1½ inches in each direction and will weigh about ⅞ lb. The shot shall be made of ordinary machinery cast iron, and all edges shall be made

rounded to a radius of about ¼ inch. The individual shot shall be replaced by new pieces whenever they shall have lost one-tenth of their original weight. For the standard size of rattler the standard charge of shot shall consist of 75 lbs. of large shot and 225 lbs. of small shot.

3. *Number and Condition of Brick.* For the standard size of rattler, twelve paving bricks or nine paving blocks will constitute the number to be used in a single test, but two more or less than this number may be used. The bricks shall be thoroughly dried before testing.

4. *The Test.* The rattler shall be rotated at a rate of not less than 28 nor more than 30 revolutions per minute, and 1800 revolutions shall constitute the standard test. The speed requirement is important.

5. *The Results.* The loss shall be calculated in percentages of the original weight of the dry brick composing the charge. In weighing the rattler brick, any piece weighing less than one-half pound shall be rejected.

6. *Variations in Size of Rattler.* Rattlers 28 inches in diameter and of a length greater than 20 inches may be used, in which case the charge of shot and the number of brick shall be increased proportionally to the increase of length. Rattlers of smaller diameter will give losses which are smaller and which can not accurately be compared with those obtained with the 28-in. diameter. However, if 24-in. or 26-in. rattlers are used, it is recommended that the charge of cast iron shot be equal in volume to 10% of the volume of the rattler, which is about 1 lb. of shot to each 40 cu. in. of rattler volume. For a 24-in. machine, the charge should be composed of half large size and half small size of shot, and for the 26-in. machine one-third large size and two-thirds small size.

In explanation of the details specified, it may be said that the 28-in. rattler seems to be the one in most common use, and that many have been put in city laboratories by reason of the adoption of this size by the National Brick Manufacturers' Association. This size is well adapted to the purpose, though perhaps not more so than the 24-in. size. 20-in. of length will give space for a sufficient number of bricks for one test and is not short enough to endanger the binding of bricks at the end. The shape of shot given is the same as that adopted by the N. B. M. A., the exact dimensions being somewhat accidental. The proportion of the mixture is such as to give the same character to the test as is given by the half-and-half mixture with the 24-in. rattler. The necessity for having the bricks free from moisture was shown in the last report of this committee and the statements there made have been corroborated by others. 1800 revolutions will wear the brick deep enough to bring out defects which may exist below the surface. It is probable that 1500 revolutions would generally have been sufficient, but 1800 ought surely to give a rigorous test. As the rate of rotation has some effect on the abrasion, the carrying out of a particular speed is important. Duplicate tests are not among the requirements, for it is felt that however desirable it may occasionally be to have tests in duplicate, it is generally an unnecessary and useless addition. While it is quite desirable that a standard size of rattler be used, it must be recognized that this size may not always be available and hence directions for using other sizes may be of service; but it should be understood that the results of tests with smaller rattlers will not conform to those of the standard diameter and hence a different maximum loss must be specified.

It should be recognized that the purpose of the rattler test is to determine when brick fall below grade or fail to fill requirements which brick of known excellence meet, and such a test should give tangible, definite, and reliable evidence of this. It is believed that the method above outlined meets these requirements fairly well. However, we must acknowledge the limitations of such a test and not deduce conclusions which imply a high degree of refinement. For example, the rattler test should not be expected to determine the exact rank of high grade paving brick of various makes, and grading these on the basis of results of rattler tests would be futile.

Accidental or unimportant qualities may affect the results sufficiently to change the rating materially. The purpose of the rattler test, so far as it has yet been developed, is rather to determine the line beyond which the brick is not to be accepted. It is unfortunate that a misconception of the function of the rattler test exists in some quarters. At some time a test may be developed which will be so accurate as to be relied on to correctly grade even a lot of high-grade paving brick.

Some interest may be attached to the amount of loss which an acceptable paving brick will give with the proposed standard method. The best makes will average about 16%. 17½% would seem to be a proper requirement for the average loss of high grade paving brick. On account of possible variations due to the process of testing, as well as to allow some latitude in the grade of the material, it may be best to specify that while the tests shall average within 17½%, results of rattling any one charge may be permitted to go higher than this—say up to 19½%. In explanation of this, it may be said that in making a number of trials with brick selected with reference to apparent uniformity, one test out of nine gave a result 14% in excess of the average of the nine tests; the average being 16.1% and the maximum 18.3%. Part of this variation was likely due to variations in the brick and part to accidental variations in the process of testing. It seems proper to recognize this in the requirements for the brick. It is of interest to note that by the old standard N. B. M. A. method (using brick without shot), the highest loss was 45% more than the average loss—a fact which alone would condemn this method of testing.

So far nothing has been said of tests other than the rattler test. The only objection to the absorption test which is of weight is the wide range in the rate of absorption for high grade bricks of different raw material and different manufacture. A well known make of paver will absorb for its best grade less than 1% and beyond 2% the quality becomes much poorer, while for another clay and make of an excellent paver the best quality ranges between 4 and 5%.

The difficulty of specifying a limit, where a variety of bricks are to compete, is apparent. And yet it is admitted by all that for a particular make of brick the absorption test is indicative of the quality and the uniformity of any particular lot of the brick, and uniformity is one of the most important properties for a durable pavement. To try to meet the difficulties and yet secure the advantages of the absorption test the following method is suggested for your criticism:

"At the time of submitting bids, the bidder shall furnish 25 bricks of the make specified in his bid, on which a rattler test and an absorption test shall be made. A requirement of the bricks furnished for the pavement will be that their absorption tests shall fall within the following limits: When the result of the absorption test of the sample bricks is below 2%, the limits shall be ¾% less and 1% more than the sample; when between 2% and 5%, the limits shall be 1% less and 1½% more than the sample."

The bidder and the manufacturer will know whether they can furnish such material and their samples will be selected as average brick rather than as perfect brick, a variety of makes will be permitted to compete, and the allowed range in burning will give a product of the desired uniformity.

For the absorption test it is recommended that broken or rattled brick be used, and that the pieces shall be thoroughly dried before the first weighing and shall be immersed in water 48 hours before final weighing.

It is recommended that the cross-breaking test be used whenever the facilities will permit. The results give further and valuable information concerning the brick.

No specifications for the method of selecting brick for the tests are submitted, since it seems best to settle only the question of the method of test at this time, but it is felt that a statement ought at some time to be formulated regarding the method of selection and the number of tests to be made. Nor has it seemed best to present at this time further specifications for the brick themselves.

It is hoped that the matter herein presented will prove of value to the members, and it is believed that action taken by the Society in regard to a standard method of conducting the rattler test will greatly aid in securing uniformity of testing and in obtaining serviceable paving material.

A. N. TALBOT,
Chairman.

DISCUSSION.

MR. D. W. MEAD: A number of years ago, when brick paving was a new thing, the speaker was representing a construction company was called upon to construct about 75,000 square yards of pavement. The upper limit for the absorption of the brick was specified at 1½ per cent. Now there are not enough brick manufactured in the United States in two years, even under present conditions, for that pavement which would be within that limit. Yet the pavement was constructed. The speaker remembers taking the matter up with the Engineer and telling him that if it was his intention to enforce the specificaton, it would be impossible to construct the pavement. The Engineer stated that all he wanted was the best brick possible and with that understanding the specification was left as it was and the contract signed.

It is very important for the Engineer to bear in mind in writing specifications, that he must specify something that can actually be done. There are frequently specifications written which can not be complied with, and if the work is carried out, they must be broken, and consequently lose their force. Specifications should state exactly what the Engineer means, and the construction should be made just as required. When engineers get into the habit of writing specifications which mean exactly what they and the contractors understand this, we will get a great deal more uniformity and a better class of work.

The idea of putting a lower limit to the amount of absorption is somewhat of a new thought to the speaker. He is favorably impressed with it, especially for the class of brick in which the absorption is comparatively small. However, there may be objections to the limits stated; for example, the author would make a lower limit of ¾ per cent. and an upper limit of 1¾ per cent. for brick which would average 1¼ per cent. In this class we often find that the best brick would run lower than ¾ per cent. The speaker believes that it would be almost impossible to purchase brick if it were known that such a requirement was to be rigidly enforced. Therefore the speaker would hesitate to recommend the lower limit stated. It might be well to change it in such a way as to give greater range.

For some years the speaker was opposed to the adoption of a standard method for testing, but with the exception stated, he is now in favor of adopting this report. He believes that the time has come when a definite stand can be taken. We now have a definite basis, and specifications can be adopted to the method of testing.

MR. GROSS: The Department of Agriculture is now prepared to make any test of material used on public highways, and it will be done without cost. They will be tested and returned. Tests will be made for municipalities if the time is available.

The recommendations of the Committee regarding the rattler and cross-breaking tests were adopted by the Society. The matter of the absorption test was referred back to the Committee.

PROPOSED STREET RAILWAY SUBWAY SYSTEM FOR CHICAGO.

BY W. H. ROSENCRANS.

That the City of Chicago is in great need of the adoption of some radical measures for the relief of the present congested condition of all kinds of traffic in the down town district no thoughtful student of the City's needs can doubt for a moment.

The Elevated Railroads with their downtown loop were supposed to relieve this district in a measure, but while they do an enormous business the surface lines seem to be fully as busy as before the Elevated loop went into operation.

The most practical solution and the one which will unquestionably furnish the most lasting benefits is a system of subways equipped electrically, making it possible to eliminate all surface lines north of Twelfth Street and east of the River. The streets may then be paved with asphalt, the sidewalks widened, and electric wires, gas and water mains, and sewers may be placed in this subway, when the necessity arrives to rebuild them.

In the construction of a subway the many difficulties to be met and overcome have been studied, and a *deep level subway* seems to be by far the most practical. All the work of construction may be done by modern methods of tunneling, and the only openings to the surface of the streets will be at shafts, tunnel ends, and the larger station locations. By this method the business within the district traversed by the subway system, which is probably greater than any other like territory in any other city in this country, need not be seriously interfered with. Unlike Boston or New York City, this subway is a system of tunnels instead of a single line on one or two streets.

By the deep level tunnel method of construction, the present systems of sewers, gas mains, water mains, and electric wires need be but little interfered with until the completion of the subway in which provision will be made for taking care of all these mains and wires. The tunnel method does not necessitate the stopping of work during stormy weather; and, if for any cause the work is supeneded on any line it does not block business in the whole district adjacent. The transportation to the wharves and railroads of the material excavated can be done in the completed tunnel without interfering with the surface traffic in the least. Considering all these points, it would seem that, as a matter of utility and also from an economic standpoint, the deep level subway as compared with the surface cut should certainly have the preference.

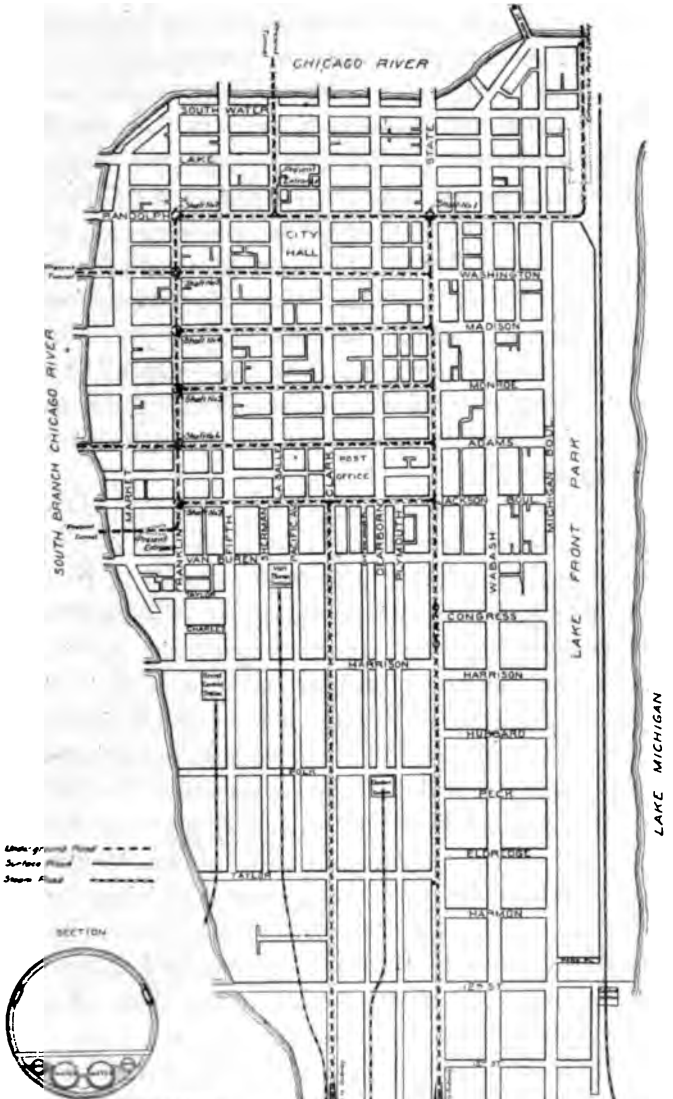
The minimum depth of the upper arch of the tunnel below the street surface would be about 16 feet. The average depth of sewers in the business district is about 12 feet. All other pipes and wires are, of course, nearer the surface.

The depth of the invert of the tunnel using a 28 feet bore, would be 44 feet. The substratum in the limits of these depths in the district under consideration is admirably suited for the tunnel method of excavation.

The material is clay which, while it stands in a firm bank, yields readily to the pick and shovel.

The Hastings tunnelling shield which was used in the 25 ft. tunnel in Chicago on 39th Street, would work even better here; for, while the sandy nature of the upper strata and the shallowness of the cut to the top of the tunnel allowed the compressed air to escape and seriously impede progress at times, the nature of the material in this instance would eliminate that difficulty entirely.

The accompanying plat shows a proposed route which would afford ample facilities for accommodating the surface street-car lines which converge from the North, the West, and the South.



MAP OF PROPOSED
UNDERGROUND STREET RAILWAY
SYSTEM
FOR
CHICAGO

Double tracks should be laid on each line and the necessary switches, crossovers, etc., placed as required to accommodate the different interests. The scheme contemplates an outer loop traversing State Street, Randolph Street, Franklin Street, and Jackson Boulevard. Two arteries enter from the West on Washington Street and Van Buren Street, two on the North by La Salle and the Park subway, and two on the South by State Street and Clark Street. Cross intersecting lines within the outer loop should be built on Washington Street, Madison Street, Monroe Street, and Adams Street. This would complete the system and provide ample room and facilities for handling the heaviest traffic in the most expeditious way possible. This plan of location, while it provides extraordinary facilities, is nearly 4000 feet shorter than other plans suggested which are equally comprehensive.

The construction of this proposed subway system should be commenced at three different points; 1, at 12th St., disposing of the dirt by way of the railroad; 2, on Washington St. on the West, disposing of the dirt by way of the river; 3, and also commencing the North Tunnel on La Salle Street, dumping the dirt into scows. Under favorable conditions, each terminal line could be dug at the rate of one foot an hour or 24 feet in a day working three shifts of 8 hours each. The tunnel walls would be built on an improved system of concrete construction. The construction of walls and completion of the lining of the tunnel must keep pace with the digging. At this rate, 72 feet of completed main line of tunnel would be made each day. Stations should be located within buildings adjacent to the line where possible, and at points where this is impossible the openings should be on the sidewalk. The total climb from the floor of the car to the surface of the street would be about 32 feet, or not more than most of the elevated stations require.

In this paper the author has attempted to present a few of the reasons for a Street railway subway in the City of Chicago, together with suggestions on location and construction. It would be impossible to deal with so important and complicated a subject and do it justice in a single paper. It would require a volume. A few years ago the mere mention of the subject in Chicago would have been considered a pleasantry. But with the completion of the Boston subway and the commencement of the New York subway, Chicago has awakened to her own needs. Mayor Harrison has recommended it in his annual report of 1900, and much discussion of the subject has been indulged in.

It is with a feeling amounting to conviction that the author predicts that that spirit which made it possible for Chicago to have a World's Fair unexcelled in History, will assert itself again, and that Chicago will have in the near future a Subway System which will be the marvel and the admiration of the cities of the civilized world.

DISCUSSION.

Mr. E. E. R. **TRATMAN**: The speaker believes that the rate of progress in the tunnel work stated by the author, 72 feet per day, is very much exaggerated.

STAKING OUT AND COMPUTATION OF EARTHWORK.

By A. L. KUEHN.

I. STAKING OUT.

The most common case of earth construction and that in which any difficulty in staking out is experienced, is that of an embankment or excavation having a given top or bottom width and fixed side slopes, as a railway bank or cut. The staking out consists in marking points on the lines of intersection of the slope planes and the ground surface. The lines of intersection will be irregular, depending on the nature of the ground; they should be well defind by the "slope stakes" which serve as guides in breaking ground and give limits of dump. The stakes are usually set 100 feet apart, opposite the regular station stakes, and this defines the lines well enough.

The process of placing the slope stakes is one of estimation and trial, and the speed attained depends almost entirely on the accuracy with which the rise and fall of the natural surface is estimated. The position of a stake is first determined as closely as possible by eye, then the distance out and elevation of the point is measured and if it is found not to be on the slope line another point is taken and so on until the intersection point is found.

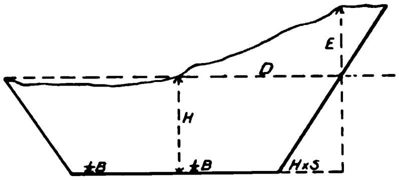


FIG. 1.

In Fig. 1 the center height is known from the given elevation of the ground and grade. Now if the ground were level the distance from the center stake to the slope stake would be one-half the base plus the center height multiplied by the slope,—the slope being the number of feet the slope line goes out as it goes up 1 foot,—or, stated in formula:

$$D=\frac{1}{2}B+HS.$$

Noting the ground at D feet from the center stake we estimate that it rises E feet, therefore the slope point is at least $E \times S$ feet farther out and, unless the ground is very steep, this point is as close as it is possible to estimate. The elevation of the estimated point is measured by reading on it with a rod and level and its distance above the grade plane is determined. This distance is called cut or fill. If the distance of the point from the center stake is equal to the cut multiplied by the slope plus one-half the base, the point is the slope point sought, if the computed distance out is greater than the actual distance, the point is farther out and if it is less the point is farther in, and other points must be taken until the slope point is found.

From this description of the process it will be noted that much estimating must be done and experience is all-important in order to obtain speed. When we consider that it is most difficult to estimate elevations it would seem that it would take some time to become adept in setting slope stakes; however, this is not the case. The principal part of the work is that of checking the estimates by actual measurement and errors are immediately brought out and if the man notes them he soon becomes quite proficient.

Aids in the Arithmetical Work.—The arithmetical work in setting slope stakes consists of two parts: First, the determination of cut or fill; and second, computing the corresponding distance out.

We may compute the cut or fill in any of three ways. 1.—We can determine the elevation of the point, and knowing the elevation of grade we obtain the cut or fill by simply taking the difference. 2.—We know the center cut or fill and a rod reading on the center, therefore the difference between the center rod and any side rod gives

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the difference in cut or fill at the center and the side point; adding this difference to or subtracting it from the center cut or fill, as the case may be, gives the side cut or fill. 3.—We know the height of instrument and the elevation of grade; the difference between the two gives the grade rod and the difference between this grade rod and any ground rod is the cut or fill at that point. Stated in a few words the method is this:—Grade rod minus ground rod gives cut or fill. It is to be noted that if fills are called minus and cuts plus, the sign of the difference will always determine whether there is a cut or a fill at the point.

The last two methods are the shortest and are used generally.

The additions and subtractions indicated in the above three methods may be done mechanically by what is known as a tape rod. This consists of a rod 12 or 14 ft. long, around which is slipped an endless tape. The zero of the tape is at any convenient point and the graduation runs both ways from the zero, upward the foot marks are lettered 1, 2, 3, etc., and downward 9, 8, 7, etc., each graduation running half way around.

Consider this rod to be set on a bench mark and the tape be moved so that it reads the difference in elevation between the B. M. and the grade at a given station (only the units and tenths will be set) at which there is a fill. If the rod is raised or lowered the reading will always give the distance of the bottum of the rod below grade at the station selected and this reading therefore gives fill, the addition and subtraction is done mechanically. If we have a cross section of cut we note that any rise in the ground means more cut but the rod subtracts if we raise it. Now, if we invert the rod, raising it will add and lowering it will subtract, so that we must use the inverted rod in case of cuts.

This device saves mental labor and a gain is made in speed. The objections to it are that the rod must be reset for every station at which there is a change of grade elevation and that the rod must be inverted for use at cuts. The objection is also made that the tape is not accurate enough for use in checking bench marks and another rod must be carried. However, graduation may be placed on two sides of the rod and this objection is overcome.

The second part of the arithmetical work is that of computing the distance out corresponding to a cut or fill as determined above. This consists in multiplying the cut or fill by the given slope and adding one-half the base. This work is greatly facilitated by a little diagram of the sections to be used. The distance out corresponding to a given cut or fill can be read off at once. This work can, however, be done mechanically as well as the determination of cut or fill, in fact much more easily. The device used is what is known as "Ward's Tape".

This tape is constructed as follows: On the back of an ordinary metallic tape is marked a distance from the zero end equal to one half the base, from there on it is graduated so that the reading gives the cut or fill corresponding to the distance out, as shown by the tape. For example, at a distance out 11½ ft. for a 20 ft. base and a 1½ to 1 slope, the cut or fill will be 1, at 13 ft. out 2, etc. These points are marked and the distance between them divided into ten parts, making the reading to tenths. To use the tape, we first determine cut or fill at an assumed point and then note if the reading on the back of the tape corresponds to it; if not the rod is moved in or out as may be the case.

The objection to this method is that for every new width of roadbed a different tape must be had and confusion is liable to result.

The mechanical devices mentioned reduce the mental work to practically nothing and the possibilities of mistake are reduced and a gain is made in speed. However, the possibility of mistake in cross-sectioning is quite small in any case if notes are properly checked, since a fixed relation exists between cut or fill and the distance out for slope points.

Level Board. So far mention has been made of the ordinary level only for obtaining cuts or fills. On steep ground the level must be reset several times at each cross-section and slow progress is made. For this class of work a level board greatly facilitates the work.

This level board is simply a light pine board about 6 or 8 in. wide and 1 in. thick, preferably 10 ft. long, provided with levels near the ends. One edge of the board is graduated to tenths.

To use the level board we must first know the center cut or fill. It is held with one end on the ground on the center stake (if the ground is descending) and the drop at the other end is measured with a short rod and the cut or fill determined. If the slope point is farther out, the point just determined is taken as a turning point and the cut or fill 10 feet farther out ascertained. As soon as the board is over the slope point the rod is held at several places until the point is found.

The accuracy of this method is not as great as obtained by the use of the ordinary level, but the limit of accuracy (using a little care) is far within that required of the work.

Setting Grade Points. In running from cut to fill, stakes should be set to define the line of intersection of the plane of the roadbed and the ground surface. At least three stakes are necessary, one on the center line and one at each side. Since the roadbed is usually wider in cut than in fill the side stakes should be set to mark the widest base in order to give the limits of the work. The finding of a grade point is a matter of trial just as setting the slope stakes. If the grade is not level the grade elevation must be figured for each assumed point and then the cut determined. The rod must be moved about until a zero cut is found.

The condition which usually obtains is shown in Fig. 2.

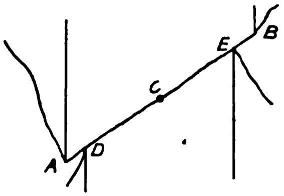

FIG. 2.

A, B, C, D, and E are grade points, stakes being set at A, B, and C. Cross sections are usually taken at A, B, and C; however, if the line A, C, B is not much inclined it is well to take only the plus of C and assume that the line A, C, B is perpendicular to the center line. The error caused in the volume is insignificant and the time in taking the two extra sections is practically wasted; the stakes A and B should however be set in their true position to serve as guides for the work.

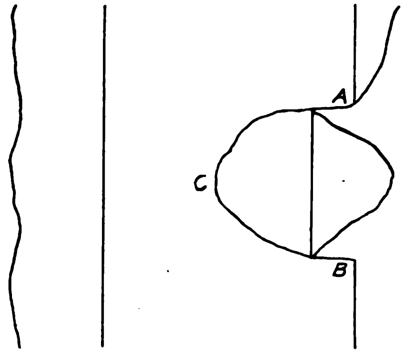

FIG. 3.

In Fig 3 is shown a case where the cross section is part cut and part fill for a short distance. Stakes should be set and cross sections taken at A, B, and C.

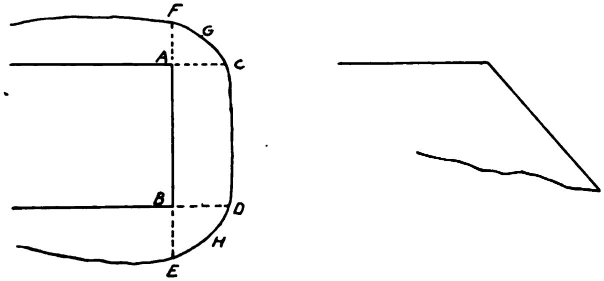

FIG. 4.

Staking Out End of Bank. In Fig. 4 is shown the condition found at the end of an embankment. All slopes are the same as the side slopes and we have, therefore, a wedge A, B, C, D, and two cones FAC and EBD. Stakes should be set at F, C, D, and E, and if the bank is more than 10 feet high stakes should be set at G and H, to aid in construction.

Cross Sections on Curves. The super-elevation for the outer rail on curves should be allowed for in finishing off sub-grade. This somewhat affects the position of the slope stakes.

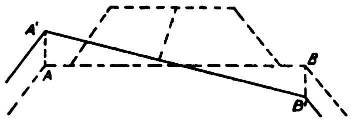

FIG. 5.

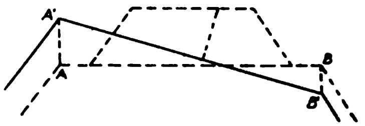

FIG. 6.

Consider the case of a plane sub-grade as shown in Figs. 5 and 6. The base A′ B′ should be of standard width. However it simplifies matters materially to make it of such width that its projection A′ B will be of standard width rather than the inclined surface. A′ B′ will then be at most two-tenths wider and it is advantageous to have it so.

In Fig. 5 is shown the case when the center of track is kept at grade. The slope stake on the outside of the curve must be set for a grade which is A′—A higher than the given grade and the inner stake must be set for a grade which is B—B′ lower.

In Fig. 6 is shown the case when the inner rail is kept at grade.

If center of track is kept at grade

$$B - B' = A - A' = \frac{1}{2} b \times \frac{5}{e} = 0.1 \times b \times e \text{ (very close.)}$$

If the inner rail is kept at grade

$$A - A' = \left(\frac{1}{2} b + 2.5\right) \frac{e}{5} = \left(\frac{1}{10} b + 0.5\right) e \text{ (very close)}$$

$$B - B' = \left(\frac{1}{2} b - 2.5\right) \frac{e}{5} = \left(\frac{1}{10} b - 0.5\right) e \text{ (very close)}$$

In which e is the super-elevation in feet.

If sub-grade is crowned the inclination will affect the drainage and it is usually advisable not to crown on a curve, let the drainage be down one side.

Staking out Borrow Pits. The need for stakes here is simply to show the limits to which earth may be taken out and to insure regular pits. Profile levels should be taken on lines 10 to 100 feet apart, depending on the nature of the ground.

The utmost care should be taken to preserve the reference points which mark the positions of the lines on which the profiles were taken as the profiles are destroyed as soon as the ground is removed. After all the earth required has been removed profiles are again taken on the lines first established and when the two profiles taken on a line are platted the area removed is shown.

Allowance for Shrinkage. In setting slope stakes no allowance must be made for shrinkage for the bottom line of a bank does not shrink—it spreads if anything. The only allowance for shrinkage or squatting is made in the final grade stakes, and its amount is determined by the method of making the bank and the kind of material used. It ranges from 2 to 3 per cent. for banks made up by horse and wagon to 10 to 12 per cent. for loose earth and wheelbarrow work.

Errors in Setting Slope Stakes. It is impracticable to set slope stakes closer than to the nearest tenth and this is the usual practice. As far as the stake serving as a guide in construction it is accurate enough if set within four or five tenths. The recorded disance out should, however, correspond to the observed cut or fill as this will cause the least error.

The maximum error in area caused by an error of one tenth in distance out is about as follows:

For a 12 ft. roadway, 1 to 1 slope, 2 ft. center height. .0.7%
For a 20 ft. roadway, 1 to 1 slope, 10 ft. center height. .0.3%
For a 16 ft. roadway, 1½ to 1 slope, 5 ft. center height. .0.4%

Say an average of 0.5% in any case. The greater the center height the less will be the error. Since, however, in a number of cross sections the errors will tend to balance, the error in volume will be less than this.

Another error in determining the area of a cross section results from the fact that the ground is not a sraight line between two points as is assumed.

The maximum error caused by a deviation of one tenth from a straight line is about as follows:

For a 12 ft. roadway, 1 to 1 slope, center height 2 ft. . . . 3.0%
For a 20 ft. roadway, 1 to 1 slope, center height, 10 ft. . 0.7%
For a 16 ft. roadway, 1½ to 1 slope, center height, 5 ft. 0.8%

Say an average error of ¾ of 1 per cent. in any case. The larger the cross section the less will be the error.

Here again there is a compensation and total error in volume will be less than this. However a deviation of one tenth is imperceptible and a matter of two or three tenths is hardly taken notice of, so that this error may be material. It will be small in a uniform ground and where the hills and hollows are about equal. It will be a maximum where the surface curvature is all in the same direction and may be as much as one per cent.

The errors stated tend to balance in themselves and balance each other, so that the maximum error in volume is less than the sum of the two. It is in ordinary cases less than one per cent., being much less in uniform country and nearly one per cent. when the curvature is all in one direction.

Distance between Cross Sections. The distances between cross sections are determined by the nature of the surface, but stakes are usually set only at the full stations. For uniform surface it suffices to take sections every hundred feet and in rough ground intermediate sections must be taken as required.

If volumes are to be computed by the method of mean end areas or by mean end areas and prismoidal correction, the lines joining corresponding points in adjacent sections should be as nearly as possible straight lines. If the volume is to be computed by the prismoidal formula and middle sections are measured there should be a uniform curvature between the end sections. The cross sections should be placed so that these conditions will be fulfilled as nearly as possible.

If method of mean end areas is to be used in computing volumes, cross sections should be taken every 50 ft. if the difference in center heights is more than 5 ft. in order that errors be kept within proper limits.

Let us examine the effect of surface irregularities of which no notice is taken—for example let us suppose that instead of the ground being made up of straight lines between two sections 100 feet apart it deviates from this by one tenth. The maximum error will be about as follows:

For a 12 ft. roadbed, 1 to 1 slope, 2 ft. center height....2.8%
For a 20 ft. roadbed, 1 to 1 slope, 10 ft. center height..0.7%
For a 16 ft. roadbed, 1 to 1 slope, 5 ft. center height....1.3%
An average say of 1%.

Now a matter of one tenth occurs almost in any case and much more than this very often so that we see that it is possible to have a material error from this source. It will be small if the surface is uniform or if hills and hollows are about evenly divided. It will be a maximum when the curvature is all in the same direction.

Total Error in Measurement. Examining the above sources of error and considering that they tend to balance we may state that under favorable circumstances the total error in measurement of a volume may be less than one per cent., but under unfavorable conditions it may be somewhat more than this.

2. COMPUTATION.

It is possible to determine exactly the volume of the solids bounded by the lines measured in the field. However, advantage should be taken of slight approximations, which are perfectly consistent, in order to shorten the work.

Areas of Cross-sections.—The first step in the computations is to determine the areas of the cross-sections. This may be done in two ways.

1. By actual calculation.
2. By plotting sections and determining the areas by the planmeter.

When the areas are calculated they are divided into trapezoids and triangles whose areas are determined separately and their sum taken. This process is best stated in several formulas by which the actual computations are reduced to a minimum.

For a three level section the area is equal to

$$\left\{ \left(h + \frac{b}{2s}\right)\frac{D}{2} - \frac{b^2}{4s} \right\}$$

h is the center height, b is the roadway width, s is the slope, and D is the sum of the distances out. $\frac{b}{2s}$ and $\frac{b^2}{4s}$ are constants for a given slope and roadway so that it is only necessary to add the constant $\frac{b}{2s}$ to the center height, multiply this by one-half the sum of the distances out and subtract the constant $\frac{b^2}{4s}$

For irregular sections the formula for the area may be stated in the following simple form:

$$\frac{1}{2}\left(\frac{o}{b}, \frac{h''}{d''}, \frac{h'}{d'}, \frac{h}{o}, \frac{H}{D}, \frac{H'}{D}, \frac{H''}{D''}, \frac{o}{b}\right)$$

d'', d', D, etc., are the distances out, b is one-half the roadway, h'', h', H, etc., are cuts or fills. The products $h'' \times d'$ and $H'' \times D'$ are to be subtracted form the products $h \times d'$, $h' \times d''$, $h'' \times b$ and $h \times D$, $H' \times D''$, $H'' \times b$. This method may be expanded to any number of terms.

The multiplications may be done by a slide rule which saves a great amount of time.

The method of plotting the sections and then measuring the area is most useful for borrow pits and very irregular sections.

Volumes. Prismoidal Formula.—The exact volumes of the solids measured are computed by means of the prismoidal formula. A middle section should be measured. However, if the corresponding points on the end sections are taken so that they are connected by practically straight lines, the middle section may be computed The position of the points on the middle section are taken at the mean positions of the corresponding end points. The prismoidal formula is:

Volume in cu. yds.

$$\left\{ (A_1 + 4A_m + A_2) \frac{l \times 27}{6} \right\}$$

A1 and A2 are the end areas and Am the middle area and b the length in feet.

Mean End Areas. The most common method of computing volumes is to take the mean of the end areas and multiply this by the length, thus:

Volume in cu. yds.

$$\left\{ \tfrac{1}{2} (A_1 + A_2) \times l \times 27 \right\}$$

The volume given by this method is always too large, sometimes as much as 20%.

The volumes for three level sections are most rapidly obtained by diagrams. The quantities can be immediately read off.

It was stated that the area of a three level section was

$$\left\{ \left(h + \frac{b}{2s} \right) \frac{D}{2} - \frac{b^2}{4s} \right\}$$

Now the volume for a section 100 feet long is

$$\left\{ \tfrac{1}{2} (A_1 + A_2) \times \frac{100}{27} = \frac{50A_1}{27} + \frac{50A_2}{27} \right\}$$

and a diagram of 50-27 A may be constructed in which the center height, h, and the sum of the distances out, D, are variables. From this diagram 50-27 A and 50-27 A_2 may be read off and their sum is equal to the volume of the 100 ft. section according to the mean end area method.

Diagrams as described were constructed by A. M. Wellington and they are published by Appleton & Co.

Prismoidal Correction. It was stated that the mean end area method gives volumes too large. The excess can be computed by comparing the mean end area formula with prismoidal formula. For a level section the excess is:

$$\left\{ (h - h')^2 \times s \times \frac{l}{6 \times 27} \qquad \text{cu. yds.} \right\}$$

(h-h') being the difference in end heights, s the side slope and l the length.

For a three level section the excess is:

$$\left\{ (h - h')\ (D - D') \times \frac{l}{12 \times 27} \right\}$$

h and h′ are the center heights and D and D′ are the sums of the distances out. Tables and diagrams of these excesses, which may be applied as corrections to the volumes found by mean end areas, can be constructed. Such diagrams are included in the diagrams of Mr. Wellington referred to before.

For level and three level sections there is no reason why the mean end area method with prismoidal correction should not be used. It is very rapid when diagrams are used and any degree of accuracy can be attained by neglecting the smaller corrections.

For irregular sections the method is somewhat more complicated and if absolute accuracy is desired the prism must be divided into triangular prisms and corrections applied to each prism. Diagrams for this can also be constructed and they are also included in Wellington's diagrams. However it is perfectly consistent in all but exceptional cases to compute by end area method and make correction as for level sections thus:

$$\left\{ (h - h') \times s \times \frac{l}{6 \times 27} \right\}$$

h and h′ being the center heights of the irregular section. This applies when the slopes of the ground are approximately uniform. Any degree of accuracy may be attained by neglecting the smaller corrections, and if sections are taken so that their center heights do not differ by more than two or three feet, corrections may usually be neglected altogether.

Volumes from profiles. For preliminary estimates when no cross-sections are taken the volumes are taken from the profile. The sections are considered level having a center height as shown on the profile and the volumes read off a diagram or table.

If the ground slopes are known the volume may be more nearly approximated by reading volume from a diagram which gives volumes for different center heights and diffrent ground slopes.

This method is fully in acordance with the requirements and the error is not more than four or five per cent. from the final estimates if a little care is used.

Correction for Curvature. The volumes on a curve are first computed as if the cross-sections were parallel. Since this is not true a correction must be applied. The true volume on a curve is that generated by a mean section. It is equal to the area of this mean section multiplied by the length of the path of its center of gravity. The method of calculation is somewhat unsatisfactory because of the difficulty of determining the mean section. If both end sections are symmetrical with respect to the center line the length of the path of the center of gravity is the distance between the sections along the center line and no correction is needed, however, if there is an excess of area on one side of the center line it must be corrected for. The excess only need be considered for the remainder will just balance the other side. The correction is found by comparing the volume as computed with the actual volume generated by the mean excess area. This mean excess area is taken as the mean of the end excesses and the error is not material since the amounts involved are small.

The correction for a three level section is:

$$.00022\ M\ (d_1 + d_2)\ D \text{ cu. yds.}$$

M is the mean excess area, d_1 and d_2 are the distances out for the mean section, and D is the degree of curve. If the excess is on the inside of curve the correction must be subtracted and if it is on the outside of curve it must be added.

A diagram of the correction can easily be constructed and the corrections read off. For irregular sections the position of the center of gravity of the mean excess area must be found either graphically or by calculation and the correction computed, however, in all but exceptional cases the formula stated for three level sections may be used.

Volumes at Grade Points. The volumes at the end of a cut are but a small part of the total and much time is wasted in needless refinement. If the outside grade points are not more than ten feet apart along the center line there is no need for considering the end pyramids in ordinary cases of slopes. The end may be considered a wedge terminating at the center grade point.

When the grade points are a considerable distance apart and the ground slope is steep the volumes of the end pyramids should be computed. To get the volume in cut multiply the area at the first grade point out of the cut by one third the distance between the outside grade points along the center line. To get the volume in fill multiply the area at the other outside grade point by one third the disance between the outside grade points along the center line.

If great accuracy is desired the section taken at the grade point on the center line must be considered.

Volumes at End of Banks. At the end of a bank there are formed a wedge and two cones. The volume of the wedge is equal to one half its base multiplied by its length. The volumes of the cones are difficult to obtain accurately and an approximate method may be used since the volumes are comparatively small.

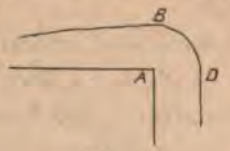

FIG. 7

To compute the volume of the cone A, B, D, we take the mean of the triangles A, B and A, D and consider it as generating the volume A. B. The length of the path of its center of gravity will be approximately,

$$\left\{ \tfrac{1}{3}\left(\frac{AB + AD}{2}\right) \times \frac{\pi v}{2} \right\}$$

This length multiplied by the area of the mean triangle will give the volume approximately.

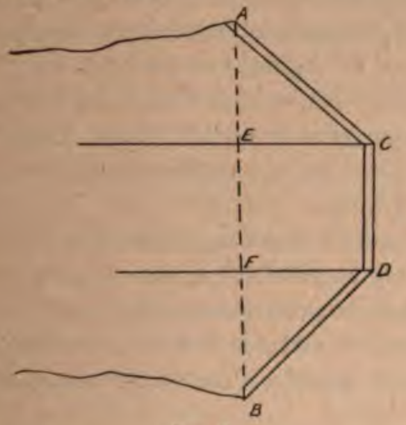

FIG. 8.

Volumes behind Abutments. A cross section should be taken on A, B, and the fills at E, F, C and D should be obtained. The mean of the areas E, C and F, D multiplied by the width of roadway will give volume E, C. F, D. Area E C plus area F D times one third A E plus F B gives volumes of A E C plus volume of F D B. The ground slope will usually be regular so that the above statement will be exactly true. However the error in any case will be small because the volumes are comparatively small.

Allowance for Openings, Culverts, etc. For small opening, culverts, etc., the bank should first be considered full, then the volume taken up by the opening or culvert deducted.

Earth to be Measured in Excavation. All the cases mentioned in which any particular difficulty in computing volumes was encountered were in fills. Now earth can be best measured in borrow pits if they are kept regular and if it is specified that all earth shall be measured in excavation much controversy will be avoided.

DISCUSSION.

PROF. A. N. TALBOT: The discussions which have recently been going on in engineering periodicals have caused the speaker much surprise. The criticisms which have been made of the methods of teaching in engineering schools have been unjust; so far as he knows, the methods taught in engineering schools in the West are practically followed by engineers in the field.

The slope tape is not new, as thought by some of the writers in the discussions; the speaker used it twenty years ago. The slope board described in the paper has been found to be very convenient, especially in steep work.

In staking out light work care should be used to set the slope points as accurately as possible; in heavy work the care should be exercised in getting cross sections at right angles to the center line. There is a tendency to take too few cross sections, especially when the ground runs out rapidly. The errors caused by this are cumulative.

The speaker has found difficulty in calculating earth work at the ends of embankments, when the transverse slope is steep. The fill at one side may be 2 feet and the other 40 feet; in this case the method is explained by the author will be greatly in error. This may be remedied by taking more points around the base of the pyramid.

MR. H. G. PADDOCK: With very wide cross sections, as those which occur in street work, the speaker has found it convenient to run auxilliary lines from which to set the slope stakes. These auxilliary lines may be from 20 to 60 feet from the center line and are parallel to it. On them are set station stakes corresponding to the stakes on the center line. Measurements are made from these auxilliary lines which saves a great deal of time.

THE INDIANA, ILLINOIS & IOWA RAILROAD.

BY O. C. WHITSELL.*

The Indiana, Illinois & Iowa Railroad runs from St. Joseph, Mich., to a Junction with the Illinois Valley & Northern R. R. (now C. B. & Q. R. R.) near Ladd, Ill. From I. V. & N. Junction to Fulton, Ill., it runs over a line leased from the C. B. & Q. R. R.

Leaving St. Joseph, Mich., the line follows up the left bank of the St. Joseph River for one and one half miles skirting the bluffs; thence taking advantage of the bluffs and small streams flowing into the river the ascent is made, with a grade of thirty (30) ft. per mile, into the high ground, thence through a well settled and highly productive farming and fruit raising country, the line bears nearly due south to the State line, thence southwesterly to South Bend, Ind.

The country between St. Joseph and South Bend is rolling, but the character of the work is not heavy, averaging about twelve thousand (12,000) cubic yards per mile, grades being light. Leaving South Bend, the line passes over a few miles of almost level marshy ground, which is the extreme head of the Kankakee River; thence in a southwesterly direction, and keeping a few miles south of the Kankakee River, over a slightly rolling, agricultural country, passes through North Liberty, Walkerton, Hamlet and Knox to North Judson. From North Judson to Streator the line runs almost due west, passing through San Pierre, Wheatfield, De Motte, Shelby, Momence, Kankakee, Reddick and Dwight.

In passing through Streator the line bears to the northwest, having made three miles of Northing when it reaches Kangley. From there it runs due west to near the west line of La Salle

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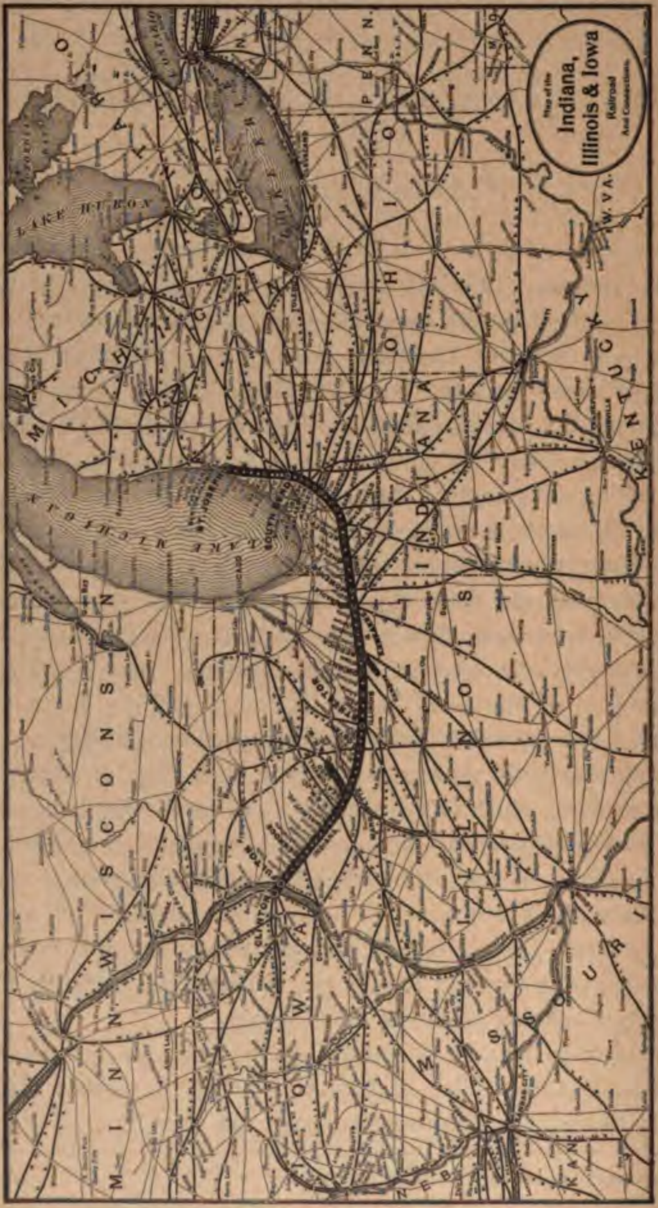
*Engineer of Construction I., I. & I. Railroad.


Map of the
Indiana,
Illinois & Iowa
Railroad
And Connections.
LAKE ONTARIO
ONTARIO
LAKE HURON
LAKE ERIE
LAKE MICHIGAN
MICHIGAN
PENN.
OHIO
W. VA.
INDIANA
KENTUCKY
ILLINOIS
WISCONSIN
MINN.
IOWA
MISSOURI
NEB.
KAN.

County; then in northwest course to McNabb, from this point it bears north to Granville. From Granville the line bears northwest down the All Forks Creek, the valley of which stream it follows to the Illinois River. Almost directly opposite the mouth of All Forks Creek a stream called Nigger Creek comes in from the north. From the Illinois River the line runs almost due north up Nigger Creek to Seatonville, crossing the C., R. I. & P. R. R. one mile west of Marquette Station and 1.2 miles east of Depue, by a fifty-eight (58) ft. span, through plate girder bridge. The C., R. I. & P. R. R. Co., has room for four tracks under this bridge and 22½ feet clear headway above top of rail.

From Seatonville the line bears east of north, still following up the valley of Nigger Creek, to Ladd where it makes junction with the I. V. & N. R. R. The length of main track from St. Joseph to Ladd is 233.5 miles. In addition to the main track, the Company has built branches from Kankakee to Bradley, two miles, to connect with the factories at that place. From Reddick to Cardiff, four miles, to connect with the Cardiff Co.'s coal mine. From C., R. I. & P. R. R. crossing to Depue, one and one fourth miles, for interchange track; from the same point to Marquette coal mine, track has been graded but is not yet laid.

From North Judson to De Motte the line runs through a flat country interspersed with sand hills; from De Motte to Momence it runs through what is known as the Kankakee Marshes, crossing the Kankakee River at Shelby. These marshes are fast being drained and converted into farm lands. From Momence to Granville the line runs through the finest agricultural section of Illinois. At Kankakee and Carrow there are quarries of building stone. At Clarke City, Cardiff, Streator, Marquette, Seatonville and Ladd, there are some of the best producing coal mines in the State. Putnam County will also be producing coal at no distant day.

SURVEYS.

In making the surveys for the extension west of Streator the preliminary surveys soon developed the fact that it was impossible to get down to the Vermillion River, from Streator, with a 0.5 grade, so the only thing left to do was to seek a narrow place and jump it, which was done.

From Kangley to Granville there are no engineering difficulties, and the question of location of line was decided by consideration of future traffic and a desire to accommodate to the fullest extent the country passed through. As All Forks Creek offered the easiest gradient for getting down to the Illinois River, although somewhat crooked, it was adopted for the reason that it was the best that could be found.

In order to reach the summit north of the river at a point as far west as possible, it was necessary to make the foot of the grade near the river and to climb over the C., R. I. & P. track. To do this it was necessary to build 4,129 feet of trestle work from twenty to forty feet high. At about the highest point on this trestle it was necessary to put in a switch for a wye track to connect with the C., R. I. & P. R. R. at Dupue and to make it possible to reach the coal mine at Marquette. This added 1,057 ft. to the length of trestle.

After passing Seatonville, the original location bore due north to Zearing, a point on the I. V. & N. R. R., two miles west of Ladd. After construction was partly completed it developed that a connection with the Chicago & Northwestern R. R. east of Ladd was needed. Arrangements were accordingly made to use the C. W. & V. Coal Co.'s track from Seatonville to Ladd and there connect with the I. V. & N. track. The line to Zearing was accordingly abandoned and the line through Ladd adopted. From Ladd a line was constructed due east for three (3) miles to a connection with the C. & N. W. R. R. Co.'s Spring Valley Line.

CURVATURE.

The standard maximum curve is three degrees for all main track outside of yard limits; but for special reasons it has been exceeded in two instances. One curve three (3) degrees and twenty (20) minutes and one four degrees. Inside of yard limits where trains are compelled to run slow, there are one six, one seven, one eight, and one ten degree curves. On the Bradley spur there are two twelve degree curves. These latter are too sharp for Mogul Engines which, although they go around the curves all right, yet on account of their longer wheel base, are continually kicking the track out of line. The curvature between St. Joseph and South Bend, with the exception of the first two or three miles out of St. Joseph is light. Between South Bend and Streator there are fifty-one (51) curves, having a aggregate curvature of 906.7 degrees and an aggregate length of 11.55 miles or 7.6 per cent. of the whole line. Of the new extension from Streator to Ladd 78 per cent. is on tangent 15 per cent. is on curves of over two dergees, and seven per cent. is on curves of two degrees and less.

GRADES.

In the original construction of the Road there was used between Streator and Budd, about two miles of 35 ft. grade and one mile of 33 ft. grade rising to the east, and between Budd and Dwight some short pieces of 30 foot grade falling to the east. With these exceptions all the grades between Streator and South Bend are less than the present maximum of 0.5 feet per hundred or 26.4 feet per mile.

With the assistance of a pusher up Budd Hill, one of the compound engines, carrying a weight of 112,000 pounds on drivers, hauls 75 loaded cars from Streator to South Bend. It is the intention of the management to cut down all grades between Streator and Dwight to a maximum of 26.4 ft. per mile in the near future. On the new extension from Streator to Ladd, this maximum was adhered to in all cases except in the crossing of the Illinois River. Here, owing to the great elevation to be overcome (272 feet), and the short distance, it was necessary to use a 0.7 grade, or 37 feet per mile. Realizing that all engines loaded for 26, 4 ft. grade would have to be pushed up this hill, and that to compensate for curvature at the rate of 0.04 feet per station per degree of curve, would increase the cost of construction from twenty to twenty-five thousand dollars without doing away with the pusher, no compensation was made for curvature on this hill.

Thinking it may be of interest, and perhaps of benefit to some of the members, the author gives below a table of distances between stations and elevations. The datum plane is mean sea level at New York City. The elevations given at stations are sub-grade.

Name of Station.	Distance between Stations.	Elevation above Sea Level.
Mouth of St. Joe River (water)	0	583.5
St. Joseph Station	0	588.5
Vineland	4.0	630.0
Derby	3.0	637.0
Baroda	4.2	640.0
Glendora	3.9	677.0
Galien	6.5	677.0
State Line	2.7	765.0
Warwick	1.5	746.0
Rugby	5.1	730.0
S. S. & S. Jct	5.8	721.0
South Bend	2.2	717.5
Ginger Hill	8.1	721.0
North Liberty	5.0	732.0
Walkerton	6.1	714.0
Hamlet	7.8	695.0
Knox	6.4	704.0
To To	4.5	707.0
North Judson	4.9	698.0
San Pierre	6.2	705.0
Dunnville	4.1	680.0
Wheatfield	4.2	664.0
Stoutsburg	3.4	671.0
De Motte	4.4	666.0
Shelby	7.8	642.0
Lineville	8.2	635.0
Momence	8.5	633.0
Exline	5.7	643.0

Name of Station.	Distance between Stations.	Elevation above Sea Level.
Kankakee	5.6	629.0
Kankakee River Bridge	0.4	626.0
Carrow	7.6	651.0
Goodrich	1.8	638.0
Union Hill	4.7	620.0
Clarke City Jct	3.6	611.5
Reddick	1.9	609.0
Wilson	2.9	615.0
Dwight	6.2	634.0
Sunbury	5.3	665.0
Adams	2.9	683.0
Budd	1.9	706.0
Two Miles West of Budd	2.0	749.5
Four Miles West of Budd	2.0	732.5
Missal	2.3	670.0
Streater Jct	3.8	619.0
Streater Depot	1.8	621.0
Streater	0	621.0
Vermillion River Bridge	2.5	617.0
Vermillion River Bed		546.0
Threeye	2.0	639.0
Milla	4.8	673.0
Summit	2.9	724.0
Illinois Central Crossing	1.3	696.5
Lostant	0.1	694.5
Priscilla	3.9	655.0
County Line 3rd P. M	1.3	664.0
McNabb	3.5	678.5
Summit	3.3	738.0
Granville	2.7	674.0
Moronts	4.1	525.0
Illinois River Bridge	2.5	466.0

Name of Station.	Distance between Stations.	Elevation above Sea Level.
Illinois River Bed	0.0	424.0
Illinois River High Water		450.0
Seatonville	4.2	607.0
Seatonville Jct	1.0	604.0
Ladd	1.3	636.0

IMPORTANT BRIDGES.

The most important bridges on the line are those over the Kankakee River at Kankakee, over the Vermillion River at Streator, and the Illinois River bridge.

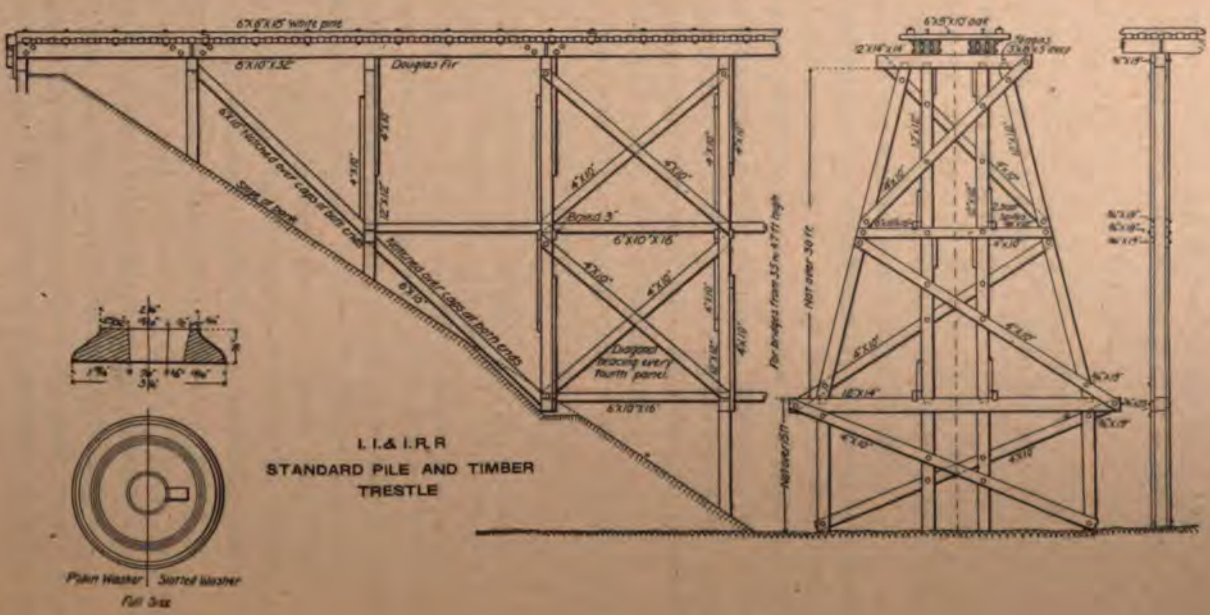
The Kankakee bridge consists of three (3) wooden Howe truss, deck spans of 138 feet each, on piers and abutments of Kankakee stone.

The Vermillion River bridge is a steel viaduct 548 feet long and 71 feet above the river bed. The viaduct consists of six 58 foot and one 50 foot girder spans supported by five steel towers of 30 ft. span and two single bents. The substructure, consisting of one abutment, three piers, and fourteen pedestals, is built of Portland cement concrete. The cost of both substructure and superstructure was $39,154.10.

The Illinois River bridge consists of one 360 ft. draw span and two 120 foot riveted steel spans. The substructure consists of first class masonry piers, built partly of Cleveland sandstone and partly of Anamosa (Iowa) limestone. The piers resting on concrete foundations which extend below the bed of the river and are supported by piles driven to a firm foundation. The structure is first class in every respect and cost when completed $101,433.70.

TRESTLE BRIDGES.

The details of construction of the trestle bridges are shown in Fig. 2, which is the standard plan as used on the extension west of Streator. This will probably be changed in the future by using 14 foot spans and 28 foot stringers, instead of 16 foot spans and 32 ft. stringers.



I. I. & I. R.R

STANDARD PILE AND TIMBER TRESTLE

Between Streator and South Bend there are 155 pile bridges, the longest being 1,694 feet and the shortest 8 feet, having a total length of 11,515 feet, this is an average of 76 feet per mile.

On the extension west of Streator the bridging was heavy, there being 44 bridges, ranging from 16 ft. to 5,186 ft. in length, and having an aggregate length of 10,367 ft. This is an average of 240 ft. per mile, costing on an average of $9.93 per lineal foot. The highest trestle is the one at the west end of the Vermillion River viaduct. It is 848 feet long and from 20 to 50 ft. high, it consists of yellow pine frame bents supported by piles, and cost $11.71 per lineal foot. The low bridges, ranging from five to fifteen feet in height, cost on an average $7.10 per lineal foot. The culverts are cast iron pipe of the weight and thickness known as Standard Gas Pipe. The sizes principally used are 18″, 24″, 36″ and 48″ inside diameter, in joints 12 feet in length.

OTHER IMPORTANT STRUCTURES.

The Company have at South Bend, a round house of six stalls 70 ft. deep, with a 60 ft. iron deck turntable.

At Kankakee, a machine shop equipped for doing all repair work on cars and engines. A six stall round house, with a 60 ft. iron deck turntable. One of the finest icing plants in the State, consisting of one house 120 ft. by 200 ft. and 30. ft. deep, holding 16,000 tons, and one house 30 ft. by 240 ft. and 28 ft. deep, holding 4,000 tons, equipped with movable platforms and modern machinery. A freight storage and transfer house 70 ft. by 450 ft.

At Butts, two miles west of Kankakee, large storage yards are being built, and already there are pens sufficient to water and feed a train load of cattel at once.

At Streator there is a seven stall round house, with a 55 ft. iron turntable, and the building of a round house at I. V. & N. Junction is contemplated.

GRADING.

The standard width of roadbed is 16 ft. in embankment and 22 ft. in excavation, with side slopes of 1½ to 1. On the first 28 miles west of Streator there was moderately light work, averaging about 11,000 cubic yards per mile. This was all constructed with wheel and slip scrapers. The next 12 miles averaged almost 64,000 cubic yards per mile and was constructed almost entirely by steam shovel and dump cars.

TRACK CONSTRUCTION.

The present standard is a 75 pound steel rail, American Society of Civil Engineers standard section, laid broken joints, on 17 ties per 30 ft. rail (2,992 per mile), and 24 inch angle bars held by four ⅞ inch bolts with American nut locks. All but about 12 miles was laid with an iron car and the ties handled by teams. The remainder was laid with track laying machine.

BALLASTING.

About ten inches of gravel ballast was put under the ties. This was loaded by steam shovel and plowed off of cars by a center ballast plow operated by an inch and a half steel cable attached to the engine.

INTER-LOCKING PLANTS.

Interlocking switches are placed at the following Railroad crossings:—C. & A. (Dwight), Wabash (Reddick), C. & E. I., P. C. C. & St. L., C. & E., N. Y. C. & St. L., P., F. W. & C., B. & O., L. E. & W., Wabash (North Liberty), L. S. & M. S. at South Bend, L. S. & M. S. at Rugby.

The rules for operation of these plants are as follows:

INTER-LOCKING SIGNALS.

INTERLOCKING SIGNALS are classed as Distant semaphore, Home semaphore, and Siding Signals.

A DISTANT SEMAPHORE signal indicates Caution.

A HOME SEMAPHORE Signal indicates Danger or Safety.

A SIDING SIGNAL indicates Danger or Safety.

When the arm on the Distant Semaphore Post is in a horizontal position, or showing a green light at night, trains may pass under it, but under full control, prepared to come to a full stop before passing the Home Semaphore.

When the arm on the Distant Semaphore is lowered, or a white light is shown at night, it must not be taken for granted that the Home Semaphore is clear.

When the arm on Home Semaphore Post is in a horizontal position by day, or showing a Red light by night, it denotes Danger, and must not be passed until it is cleared.

When the arm on the Home Semaphore Post is depressed from a horizontal position by day, or when showing a White light by night, it indicates Safety, and trains can proceed.

On double track, back-up signals are located on both eastbound and westbound main lines, about 150 feet beyond the crossing, in the direction the trains run, and Trainmen and Enginemen must be very particular, if they have once passed over the back-up derails, to not under any circumstances attempt to back up until they have received proper signals. The back-up derails are controlled by dwarf or pot signals, which show a White light if all right, and Red if at Danger.

When clear signals are shown, the speed of Passenger Trains must be reduced to 15 miles, and freight trains and light engines to 10 miles per hour, until the entire train has passed the crossing.

No engine, train, or portion of train, must be allowed to stand on any portion of the track between Home Semaphore Post and crossing, as by so doing the apparatus is thereby locked and all traffic on other roads delayed. Trains requiring to stop any length of time must pull clear of Home Semaphore Post.

All train employes must be at their respective posts of duty when approaching these crossings, and under no circumstances allow their engine or their train to pass the Home Semaphore unless the Safety Signal is shown. Should the engine pass the Home Semaphore at danger the train will be derailed.

In every case a train must complete the movement after having obtained signals and passed the first derail; then, if it is necessary to go back, the signals must be called for and obtained before starting to do so.

CONSTRUCTION ON THE COPPER RANGE R. R.

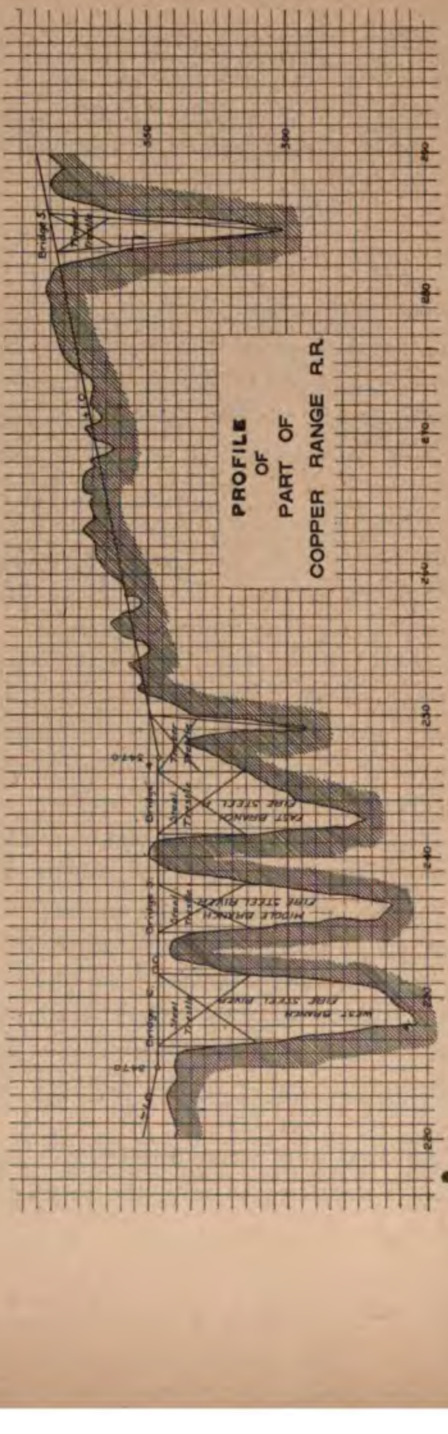
BY C. C. STOWELL.

In the extreme northern part of Michigan, is a peninsula of considrable proportions, throughout the length and near the middle of which is a range of mountains known as the Copper Range. About 40 miles from its northern extremity the range is cut by a glacial lake called Portage Lake, which is really an arm of Lake Superior and divides the peninsula, with the exception of about two miles on the west, nearly at right angles to its length. This strip of two miles, which is sand and swamp lands, has been cut by a ship canal, making an island of the upper portion. That portion of the range south of the lake, is locally known as the South Range.

The entire rangs is of volcanic origin and as its name indicates, copper is found in its rocks. The out-cropping is in a narrow belt about three miles wide extending along the range. The Indians mined for copper in this region and the finding of their stone implements as well as the pits is not a rare occurrance.

The copper is found in the metallic state, not as an ore, in veins or lodes which are from 2 ft. to 40 ft. thick, usually in small particles disseminated through the rock although masses of the pure metal weighing from a few pounds to many tons are quite common. The small particles of copper are separated from the rock by pulverizing the mass and washing away the reduced rock with water. The collected copper together with the larger masses of the metal are then sent to the smelter to be refined and cast into ingots and plates.

To obtain the amount of water necessary to separate the rock from the metal it is necessary to carry the product of the mine to


PROFILE
OF
PART OF
COPPER RANGE R.R.
350
300
Bridge 3
Steel Trestle
EAST BRANCH FIRE STEEL R
MIDDLE BRANCH FIRE STEEL RIVER
WEST BRANCH FIRE STEEL RIVER
Girder
240
230

the lake, sometimes a considerable distance. As 1% is considered a good yield it will be seen that cheap transportation from the mine to the lake and from the lake to the smelter is a necessity.

The island portion of the peninsula has been provided with railway facilities since 1873, but the South Range has been practically without an outlet for its product until the advent of the Copper Range Ry. The highways being little more than trails through the timber.

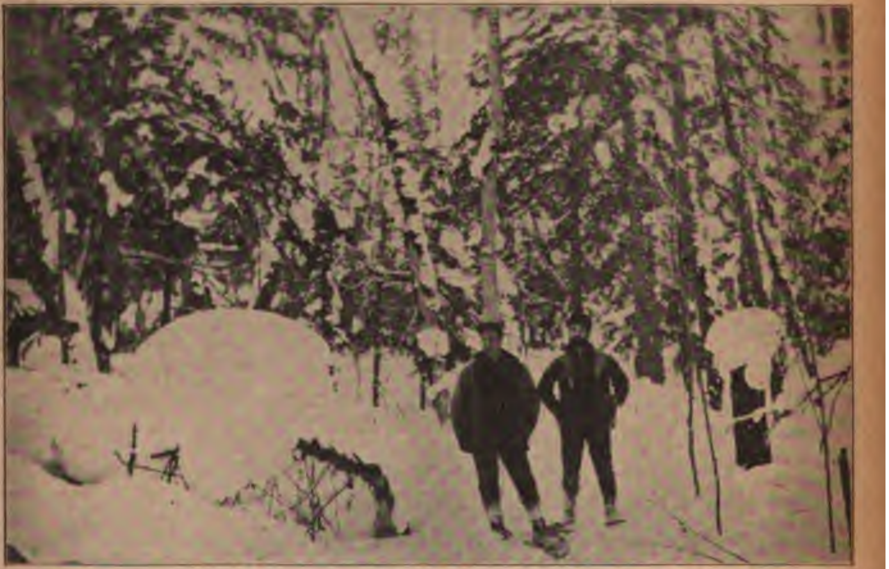
The high price paid for copper in the last few years made the mining interests in the South Range desirous of reopening the old mines and developing new ones. To secure transportation as quickly as possible some of these interests offered large land grants to the railway company, providing the company had trains running by January 1st 1900.

The survey for this railway was made from Portage Lake at Houghton to a junction with the Chicago, Milwaukee & St. Paul Ry. some 41 miles south, during the winter of 1898. The winter was unusually severe even for that locality; for two weeks the temperature was around 45° below zero, yet the survey was continued. This could not have been done in an open country, but as the line was almost entirely through heavy timber the parties were fairly comfortable in tents.

The snow falls almost continually during the winter months, but owing to the low temperature it does not adhere to the clothing or instruments as it does farther south. In its dry condition it does not pack as it falls, as it does in Illinois, but remains light and feathery and will not support the weight of a man hence it is necessary to use snow shoes. These shoes are not as cumbersome to wear as they appear and after a few days experience one becomes accustomed to the peculiar motion necessary for easy traveling.

As the snow is usually about 5 ft. deep, it buries a large portion of the under-brush and renders travel through the timber quite agreeable, except through thick evergreens where one finds snow both above and below, and the slighest disturbance of the branches brings an avalanche of snow down upon the intruder. Care must be taken however to avoid tripping with snow shoes for the snow being loose allows the body to sink deeply into its feathery mass while the shoes hold the feet to the surface. The efforts of the careless beginner to regain the outer world, and the antics of the shoes during the performance are ludicrous in the extreme.

Owing to the depth of the snow the instruments were put on shoes also. Had they been set on the ground the operator would not have been able to see out. The shoes used were empty cans fastened to the tripod legs.



A RECONNOISANCE.

The transit hubs were driven in the ground as usual, wells in the snow having been dug for the purpose; stakes 6 ft long were used for center stakes. The ground was not found frozen under the body of snow. Limbs and trees of surprising dimensions could be snapped off with a quick jerk during the cold weather.

The preliminary work for grading was begun about the middle of April, 1899. Considerable difficulty was experienced in re-running the located line, especially in rough sections where several preliminaries had been run, owing to the brush being cut 4 ft. or 5 ft. above the ground forming a network about breast high, hard to penetrate. The benches for the levels were found in some instances cut in trees higher than the instrument could be set so that the rod was reversed to take the reading from the bench.

Instruments were left at night where work ended for the day. Being accustomed to city work it was some time before the author could rid himself of a feeling of carelessness; but as it was probable that no other human beings were within miles of the place the feeling was groundless. Precautions were necessary however to guard against falling limbs, and the porcupines which would destroy axe handles and flag poles if left within their reach, apparently for the little salt left on the tools from the hands.

The contractors experienced great difficulty getting their tools and supplies to the work owing to the condition of the roads. This was notably the case on the south end, where the soil for the first 9 miles was clay. The highways had received but little attention from the authorities and roads had to be built from the highways to the work, requiring considerable corduroy. Some idea of the condition of the highways on the south end of the work can be had from the fact that the two horse rig locallly called the stage, required two hours to traverse 2½ miles of this public thoroughfare, during the greater part of April and May.

The grading of the 9 miles of railway referred to, was very difficult as the season was very wet. Owing to the extensive mining operations and the enforced idleness on account of the weather, the contractors found it difficult to hold men on the work. For a portion of the work, $3 per day was paid for labor. The ruling wages paid were $2 per day for labor and $5 for teams.

The right of way was cleared and the timber burned, no attempt being made to save it.

Grades and alinements were temporarily changed; cuts and fills narrowed; temporary trestles built of logs taken from the adjoining timber, to take the place of some of the heavier fills, and approaches to bridges. A portion of the timber only was placed in the bridges, and all things consistent with safety were done or left undone to hasten the work. Finally in October, the railway company assumed control of the work and concentrated forces on this division. Work was pushed day and night; roads were cut and track material drawn around incomplete bridges, and on Dec. 27th, four days before the time limit, a train was run from one end of the line to the other; the track having been connected and the copper spike driven about 6 miles from the southern terminus of the road. The copper for the spike was taken from the rocks excavated in the station grounds at Houghton, and made in the company's new shops.

A COOL RECEPTION AHEAD.

Within the six miles referred to above were five bridges; four within a space of 1¼ miles and three separated by sharp ridges about 200 ft. wide. (See profile). The first bridge from the south was a pile trestle 125 ft. long and 36 ft. high. The second, third and fourth were steel structures (Described in Engineering News, May 31, 1900), and were 510 ft., 330 ft. and 450 ft. long; and 92 ft., 84 ft. and 74 ft. high, respectively.

BRIDGE NO. 5.

Bridge No. 5, near which the copper spike was driven, was a timber trestle, 282 ft. long and 80 ft. high. At the north end of bridge No. 4 was a timber trestle 315 ft. long and 55 ft. high, built in place of an intended fill or bank.

The steel work was placed on concrete piers and plans were drawn for concrete abutments, but owing to the treacherous nature of the ground and the difficulty of getting material for the concrete on the work, pile abutments and approaches were substituted.

After connecting the track, attention was given to *building the road,* for out of 1,020,000 cu. yds. of excavation called for in the contract, approximately only 700,000 cu. yds. had been completed up to Jan. 1, 1900. Steam shovels were put in operation and have been at work this past season and to date, Jan. 1, 1901, the work is not complete.

Some perplexing features developed along the work which were new to the author and may be of interest to the Society. The clay is what is generally known as joint clay; extremely hard, and at some points approaching shale. A pick hardly makes an impression in it when dry and it blasts fairly well, but it is as full of disagreeable qualities when wet, as one seldom meets. When a cut was completed in this hard material a portion of the slopes, in the most unexpected places, would suddenly leave its long resting place, and slip gracefully and silently down to the track, displacing or covering it.

In some of the cuts pockets of quick sand were encountered and such spots were corduroyed in order to take out the material around them, after which they could be excavated.

Some of the banks placed on side hills, made of the material from clay cuts during the winter, probably contained frost and some snow throughout the mass. When the spring rains came these would, with little warning, slide from under the track and assume a slope approaching 4 to 1. One of these slides at Bridge No. 4 overturned trees and crossing a narrow ravine slid some 12 or 14 feet up the opposite side. The accompanying photographs show this from both directions along the track.

At Bridge No. 5, the piles for the foundations were driven from 12 ft. to 20 ft. into the soil through very hard material. A culvert was placed under the bridge to allow the bridge to be filled. The excavating for this culvert was so hard that the contractor was paid rock prices for it. Aprons were placed on the bridge to guide the dirt from the braces to prevent breaking them. When considerable material had been deposited along the sides the ground under the fill seemed to compress and carried the piles under the batter posts gradually down some 10 inches. As the fillings progressed and the middle became filled the whole central portion of the bridge settled about one foot. In another bridge, one pile bent was carried down 26 inches during the process of filling, while those next to it were only slightly disturbed.

SLIDE OF CLAY FILL.

Immediately adjoining this clay district was one of fine sand, with short sharp, cuts and fills. One of these fills was approximately 120 ft. long and 30 ft. deep. The entire watershed tributary to this ravine above the fill was but a few hundred square yards. As there was earth to spare the ravine was filled on the upper side nearly to a level with the track. There was no other material than the fine sand in the fill and so far as could be learned by surface examination, nothing but sand underneath it. One morning, soon after the opening of spring, the section men noticed that the track was out of line on this fill and stopped to reline it; but before they had taken their

SLIDE OF SAND FILL.

car from the track, the bank suddenly seemed to change to a liquid and literally flowed from under the track and went with a rush down the ravine, sweeping trees before it and leaving a clear path behind for some 500 ft.

The remaining sand in the fill behaved like quicksand and logs 20 ft. long were placed close together on the bottom and a sill for a trestle bent put on them to support stringers from cribbing at each side of the ravine.

DISCUSSION.

PROF. M. S. KETCHUM: The speaker was very much interested in the report as he was in the locality at the time this survey was made. He had charge of construction of a steel stamp mill during the winter referred to. While work was going on on this mill the temperature was often 40 degrees below zero.

The peculiar soil described is found in many places in the West. Along the Columbia River the soil is shifting all the time.

In 1893 the speaker was engaged in surveying lines in the locality of the Copper Range, and had great difficulty in getting through the marshes. The timber was so thick that it had to be cut, and the soil so soft that an instrument would not remain in position. It is extremely difficult to do work in the summer, the winter being much to be preferred.

REPORT OF THE COMMITTEE ON RAILWAYS.

To the Illinois Society of Engineers and Surveyors:

Gentlemen: — The committee, in presenting its annual report, would state that the work of railway construction and improvement during the year 1900 was fully as great and as important as that of 1899. The mileage of new railways built in the United States was a little greater. 4,800 miles in 1900 as against 4,500 in 1899, and but for the depressing influence always felt in the year of a presidential election, the new mileage would probably have been considerably greater. The widespread work of improving the existing lines has been carried on, however, on a larger scale than ever, and by nearly all important roads. The rapid development of long distance electric railways, which are beginning to form a class by themselves, is a matter of importance and interest to the engineering profession. Several papers on railway subjects were promised to your committee, but in spite of repeated requests and reminders only a few of these have materialized.

The subjects which have been taken up in this report are as follows: (1) The Railways of Illinois; (2) Permanent Improvements on Railways, and (3) Long Distance Electric Railways.

RAILWAYS IN ILLINOIS.

Illinois still holds its own as the greatest railway State in the country, having about 11,200 miles of road. Next to it ranks Pennsylvania, with 10,500 miles, but the latter State built more than twice as much as Illinois during the years 1900 and 1899. The annual reports of the Railway and Warehouse Commission of Illinois are prepared for the fiscal years ending June 30, and your committee is indebted to Mr. F. G. Ewald, Consulting Engineer to the Commission, for advance particulars of the report for the year ending June 30, 1900 which report will not be issued until some time in January, 1901. There are two classes of railway properties that submit reports to the Commission: (1) corporations operating steam railways, and (2) those operating elevated and surface electric railways, all of which, of course, are incorporated under the General Railway Act. While all of the elevated electric roads submit annual statements to the Commission, all of the surface electric roads have not done so as yet.

Steam Railways:—The following advance information is taken from the annual report for the fiscal year ending June 30, 1900.

	1899 Miles	1900 Miles
Length of line owned, main line and branches..	10,799.64	10,817.10
Second, third, fourth and additional main tracks	1,484.71	1,548.71
Industrial tracks..........................		164.61
Yard tracks and sidings....................	4,133.52	4,248.86
Total increase in mileage of all tracks in Illinois for the year..........................		388.41
Total length of new line built during the year..		103.52

It will be noticed that while the total length of new line constructed during the year was 103.52 miles, the increase of main track mileage in statement only appears to be 17.46 miles. This discrepancy is due to the fact that for a number of years back, the statistical tables contained mileage of "industral tracks" which was submitted by railway companies as main line or branches. This year Mr. Ewald has eliminated the mileage of such tracks from mileage of "main line and branches", and placed it in a column by itself as "industrial tracks", thus making a more correct showing.

Elevated and surface Electric Railways.—The following is a statement of the mileage reported by the elevated and surface electric railways in this State for the fiscal year ending June 30, 1900:

	1899. Miles.	1900. Miles.
Length of line owned, main line and branches	42.89	71.42
Second, third, fourth and additional main tracks	48.49	64.29
Yard tracks and sidings	5.68	13.97
Total increase in mileage of all tracks in Illinois for the year		52.62
Total length of new line built during the year		20.17

Owing to the wide difference in the character of business transacted, the statistics of the elevated and surface railways have been separated from those of the steam roads, in order that comparisons could be made with results that were alike in character. For purely statistical information, it is probable that this could be improved on still more by dividing the steam roads into two classes and the elevated and surface electric roads in two classes, viz:—

Steam railways:

- (A).—Roads carrying on a general business other than a terminal or transfer business.
- (B).—Terminal or transfer companies.

Elevated and surface electric railways.

- (A).—Elevated roads.
- (B).—Surface roads.

Naturally, the capitalization of terminal or transfer companies operated by steam, is considerably higher than steam roads transacting a general railway business; and the same may be said of elevated roads as compared with surface electric roads. Separated as above stated, we would get results for comparative purposes that would be alike in character

Interlocking Systems. Up to Dec. 1, 1899. the Railroad & Warehouse Commission had issued permits authorizing the operation of 173 interlocking systems in this State. During the 12 months from Dec. 1, 1899, to Dec. 1, 1900, permits were issued for 36 more interlocking systems making a total of 209. Of these, 9 interlocking plants have been discontinued for one cause or another, leaving a total of an even 200 in service on Dec. 1, 1900. During the same period, interlocking systems at 5 crossings were rebuilt and extensive changes and renewals made to 10 more, all of which require permits before they can again be placed in operation. The showing made in the installation of 36 new interlocking devices during the season just closed, is indeed a very progressive one and far exceeds any previous year. It is estimated that these 36 devices cost the railways $250,000. There are in use in this State 5 wheel machines, one of the early types of interlocking devices that have been in service for ten or twelve years. Where these devices are in use, all outlying functions are wire connected, and on this account, together with the fact that they have outlived their usefulness, these machines have all been condemned an an order issued by the Commission for the installation of standard machines.

Your committee would point out that an interesting matter in regard to the railways of this State is the growth of the city of Peoria as a railway center. Already 13 railways center there, two of which are local lines carrying on a local passenger traffic and general freight transfer traffic between Peoria and Pekin. The traffic is so great that to avoid complication all the yard and station work of the several roads is done by the two local companies. The number of main lines is likely to be increased from 11 to 14, as three more railways are projecting extensions to Peoria; the Davenport, Rock Island & Northwestern Ry., the Chicago & Northwestern Ry., and the Omaha, Kansas City & Eastern Ry.

PERMANENT IMPROVEMENT OF RAILWAYS.

In the last report reference was made to the great amount of work done and the enormous amounts of money expended in effecting permanent improvements to existing lines, and we have already shown that this work has been steadily continued throughout the past year. One of the most notable pieces of work in this direction is the Cascade tunnel on the Great Northern Ry. This tunnel is about two miles long, and supersedes an open air switchback line which is carried across the Cascade Range and is about 12 miles long. The tunnel line, which was completed in December, makes a saving of some 10 miles in distance, and great savings in elevation, grade, and curvature, while it will greatly reduce the trouble and expense of handling traffic during the winter. A special feature of the work is that the tunnel is lined throughout with concrete. It was built by the railway company and not by contract.

Particulars of the improvement works carried out by certain railways during the past year in this part of the country are given below, and with the exception of two railways all the work is within this State. These railways are the Chicago, Indianapolis & Louisville Ry., in Indiana, and the Grand Trunk Ry., in Michigan. These particulars are examples only, and do not by any means represent the entire work done. The improvements referred to in this connection may be classified as follows: (1) Improvement of alinement; (2) Reduction of grades; (3) Double tracking; (4) Widening embankments and cuts and protecting their slopes; (5) Establishing, enlarging or rearranging yards and terminals; (6) Filling trestles and putting in bridges or culverts for drainage; (7) Replacing timber or old iron bridges, with new steel or masonry structures; (8) Eliminating grade crossings; (9) Installing interlocking plants and block signals; (10) Building new stations, shops, or other buildings; (11) Improving the water supply and water stations; (12) Improving the track; (13) Constructing new lines, extensions, or branches.

Chicago & Alton Ry. About a year ago and after the reorganization of the company, the directors made an appropriation of some $15,000,000 for a thorough improvement of the road and its equipment. Extensve work is in progress in reducing grades and curves. Between Kansas City and Slater, 13-½ miles of grade have been changed, and from Springfield to Bloomington grades have been reduced on nearly 14 miles of track, making the maximum grade, with one exception, ½ of 1 per cent. Between Bloomington and

Chicago grades have been reduced on 12.7 miles of track. The bridge over the Missouri River at Glasgow has been replaced by a new structure at a cost of nearly $1,000,000. The renewal of 60 bridges has been completed, work on 40 more is in progress, and when completed 11,400 feet of old bridges will have been replaced by new structures or culverts. About 52,000 tons of rails have been purchased, and when all have been laid will cover 413.65 miles of track. More than 620,000 ties have been renewed, and 80 miles of track have been ballasted. Automatic block signals of the semaphore pattern have been installed between Chicago and Joliet. Extensive improvements have been made to the shops at Bloomington, and a number of new engines and cars have been added to the equipment.

Chicago & Northwestern Ry. Extensions and improvements have been executed at various parts of the system. On the Galena Division work has been in regard to yards and terminals, replacing old bridges with new steel structures, putting in interlocking plants and block signals, building new structures, and improving the track construction.

Chicago & Western Indiana R. R. On the Belt line on W. 45th St. a high single track timber trestle 1.1 miles long, has been replaced with a double track embankment; 1 railway and 10 streets are crossed by double-track plate girder bridges of soft steel on abutments of Portland cement concrete. At four of the streets the parapet walls, the steps of the wing walls, and a veneer to the body of the abutment are of stone, the remainder of the abutment being of concrete. A feature of the elevation is that none of the streets are depressed and further the clear headroom, averaging 15.5 ft. is about 2 ft. more than is called for by track elevation ordinances. This is caused by crossing the C. & N. W. Ry. where additional headroom is required. The spans vary from 66 ft. to 160 ft. Spans longer than 66 ft. have column supports, except the span over the C. & N. W. Ry, which is 100 ft. in the clear. The girder at this span is 107 ft. back to back of angles, 10 ft. deep, and is the largest railway girder in Chicago.

The Sanitary District of Chicago has completed for the Belt line a 334 ft. four-track cnter-pier swing bridge over the drainage canal. This is the largest bridge of its class in Chicago.

On the main line, an interlocking system at the 16th St. track depression has been put in at a cost of more than $35,000. There are three signal bridges and two towers operating 93 switches. The plant does away with the necessity of having to stop all the trains of the Erie, the Chicago & Eastern Illinois, the Grand Trunk, the Chicago, Indianapolis & Louisville, the Wabash, the Santa Fe, and the Chicago & Western Indiana railways at this subway. The work of throwing the signals and switches is done by compressed air.

The work of track elevation, required by city ordinance has been begun. Two additional tracks and foundations of concrete for abutments along 1.5 miles of right of way have been laid. About 0.6 mile of concrete retaining wall 10 ft. high along the west right of way line, paralleling an adjacent street has been built. No embankment has been made.

Chicago Great Western Ry. In reducing grades, an 8-ft. summit was cut down to a level grade for a distance of 2,000 ft. Trestle filling aggregated 459 ft.; and the renewing of bridges, 445 ft. Interlocking plants at grade crossings were put in at Sycamore (C. & N. W. Ry.); at Holcomb (C. B. & Q. R. R.), and at Byron (C., M. & St. P. Ry.) An elevated coal chute with 20 pockets was erected at Stockton. In improving track, 35 miles of old 60-lb. rails were replaced with new 75-lb. rails, and 50,000 cu. yds. of gravel ballast were put in.

Cleveland, Cincinnati, Chicago & St. Louis Ry. (St. Louis Division). Four trestles have been filled, one 63 ft. long, one 47 ft., and two 28 ft. Two of these were replaced by 10-ft. box culverts having concrete walls and a roof of 65-lb. rails covered with 12 ins. of concrete. One was replaced with a 16-ft. culvert of similar construction. The 63-ft. trestle was replaced by a 20-ft. concrete arch. Two interlocking plants have been installed; one having a 24-lever Union machine, and the other a 12-lever Rowell-Potter machine. At Litchfield, Ill., a new passenger station was built, 30x 110 ft. It is of frame construction, with slate roof, heated by steam, and provided with closets and lavatory. A concrete platform surrounds the building, and along the track the platform is 16 ft. wide and 520 ft. long. A smaller station has also been built at St. Mary's, Ind. The only new construction was a small spur to a coal mine, but about 65 miles of track were reballasted with gravel, and nearly 40 miles were laid with new 80-lb. rails of the Am. Soc. C. E. section.

Peoria & Eastern Ry. The new yards at Urbana were completed, 264 ft. of trestle were filled in, and an interlocking plant was installed at the crossing of the Vandalia Ry. at Mackinaw. At Pekin, a new water station was built, having a cypress tank 20x30 ft., on a steel tower 30 ft. high, supported by pedestals of concrete and stone. Severel banks were widened; and cuts ditched and provided with tile drains. All curves were re-lined, and eight miles of track were laid with 80-lb. rails.

Rock Island & Peoria Ry. A change of line at Bishop Hill, Ill., reduces the curvature from 4° to a maximum of 1° 30'; eliminates 130° of curvature and shortens the line 2,600 ft. About eight miles of 66-ft. grade (1.25%) have been reduced to 42 ft. and 36 ft. per mile (0.8 and 0.68%). A new yard has been laid out at Peoria, Ill. About 2,300 ft. of trestle has been replaced with solid bank, aggregating 79,000 cu. yds., and 426 ft. of trestle have been replaced with five steel girder structures, aggregating 209 ft. in length. New structures include a 74-ft. deck plate girder bridge on concrete abutments, and a concrete arch of 18-ft. span on the Bishop Hill improvement above noted. Two miles of new line have been built and 18 miles track with 56-lb. rails were relaid with 80-lb. rails.

Chicago, Indianapolis & Louisville Ry. The yard at Hammond has been enlarged by the addition of two miles of track. Seven spans of combination bridges have been replaced by steel bridges, and 1.05 miles of trestle have been filled in. Interlockng plants have been built at Delphi and Alida. Track improvement has consisted in laying 27 miles of 75-lb. rails, and 40 miles of gravel ballast.

Grand Trunk Ry. Some heavy work has been done between Flint and Lapeer, Mich., in the way of reducing grades, but without changes in alinement. Altogether about 30 miles of grade reduction and double tracking have been completed. In this work the Marion steam shovels have been used for excavating and loading, and the Lidgerwood rapid unloader for plowing the material off the construction cars. Several concrete abutments and a few small culverts have been built to replace wooden structures. It is probable that during 1901 about 100 miles of double tracking will be done, including a deviation of about 10 miles from the present line to avoid the heavy grades now operated near Flint.

LONG DISTANCE ELECTRIC RAILWAYS.

There is no prospect of steam locomotives being superseded by electric locomotives on ordinary railways, particularly for long distance passenger and freight traffic, and careful investigations show that electric traction has not yet been developed to such an extent as to show any economy in operation under such conditons, even if it should be practicable, which is not at present the case. Electric railways are, however, being developed to a large extent for cross country and interurban lines, operating a fairly high speed passenger traffic (but with frequent stops) and a local freight and express traffic. This subject was dealt with by the chairman of this committee in a paper presented at the annual meeting in 1900.

The Chicago & Milwaukee Electric Ry., 85 miles, will almost certainly be completed before long, by the construction of the missing link between Kenosha and Waukegan, 16 miles, but it is not probable that this will take away any of the through traffic between Chicago and Milwaukee. It will, however, develop a local traffic between the various towns and villages in a way which it would be impossible for the steam railways to do. Experience has shown that increase in facilities increases traffic, but steam railways are not well adapted to develop the small local traffic, nor would it be to the interests of the main lines to attempt to do this Another Wisconsin line is that between Appleton, Oshkosh and Neenah, 24 miles. It is proposed to unite this with other lines and eventually with the Chicago and Milwaukee line, giving a continuous line of electric railways from Chicago to Green Bay, Wis., 198 miles.

The Oshkosh and Neenah line, 16 miles, is laid on the outer 18-ft. of the 66-ft. road reservation along the section line, so that it does not interfere with the traveled portion of the highway, from which it is separated by a strip of rough ground. The curves are few and the grades light. The line has a single track, with turnouts, and is laid with 60-lb. rails of the Am. Soc. C. E. section, on cedar ties 24 ins. c. to c. Six-bolt angle bars are used at the joints, with Falk copper rail bonds attached to the webs of the rails. There are two trolley wires, avoiding the use of all overhead switches at the turnouts, and thus eliminating a fruitful source of trouble from the trolley wheel jumping off the wire. Telephone boxes are placed at all switches. Double truck cars, 43½ ft. long, are operated.

In Illinois, one of the most important lines is that now being built from Aurora to Chicago, passing through Wheaton. This will be about 35 miles in length, paralleling the Chicago & Northwestern Ry. for a great part of the distance between Wheaton and Chicago. It will enter Chicago by a connection with the Garfield Park line of the Metropolitan Electric Elevated Ry. and so carry its passengers downtown over the loop. This is expected to carry considerable suburban and local passenger traffic, and also a large milk traffic. A line is also being built between Chicago and Joliet.

The Illinois & Rock River R. R. is an electric line projected to run from Rockford to Sterling, a distance of 59 miles. It is to be standard gage, laid with 80-lb. rails; maximum grade, 2%; maximum curve, 12°. The power plant is to be located at Grand Detour, on the Rock River, which supplies an abundant water power for the operation of the road. The power plant will be equipped with two 750 K. W. alternating current generators, and will have five substations for transforming the alternating to the direct current. The road will be equipped for the handling of all traffic that may be offered, but one of the principal sources of revenue will be the hauling of milk from the dairy country along Rock River to the factory of the Anglo Swiss Condensed Milk Co., at Dixon. This road will be without any competition from steam railways as the territory occupied is at present without any other means of transportation. The line will run approximately southwest, crossing several main lines of railway whch run approximately east and west.

Among other long lines may be noted the following: Detroit, Rochester, Romeo & Lake Orion, 55 miles; Detroit, Ypsilanti & Ann Arbor, 54 miles; Detroit & Northwestern, 31 miles; Cleveland & Eastern, 55 miles; Mahoning Valley, 38 miles; Albany & Hudson, 37 miles. Most of these lines operate a freight and express business.

The overhead wire system is almost universally adopted, but the Albany and Hudson Ry., in New York State, is operated on the third-rail system. At grade crossings the third-rail is discontinued, the ends being connected by an underground cable. The cars have contact shoes at each end, 30 ft. apart. The central station plant is operated by water power, Victor turbines being used, but as the power available is limited and variable a steam plant of 1750 HP. has also been installed. The main current is generated by three alternating current three-phase 25-cycle machines, of 750 kilowatts, 12,000 volts. This current is carried by overhead cables to substations in the passenger stations at Hudson, 9 mles south of the station; North Chatham, 10 miles north; and East Greenwich, 18 miles north. Here the current is reduced to 380 volts by step-down air-blast transformers, and then converted to a 600-volt direct current by rotary converters. This direct current is fed to the third rail at the main station and the three sub-stations. The rail weighs 80-lbs. per yd., and is supported by cast iron chairs on wooden blocks on the ends of long ties 10 ft. apart. The rail is 6 ins. above the track rail.

There is no doubt that electric railways of the class above noted will be developed to a much larger extent than at present, and will continue to form a class by themselves, quite distinct from ordinary steam railways and from city and suburban electric railways.

E. E. RUSSELL TRATMAN,
W. H. ROSENCRANS,
R. C. VIAL,
Committee.

SOME EXPERIENCES IN DESIGNING A CITY.

BY BURTON J. ASHLEY.

On March 22nd, 1895, the author in company with the Rev. John Alex. Dowie and a number of others made a trip by special car to a point on the Chicago & Erie R. R., about one mile east of Griffith, Indiana, which is about thirty miles from Chicago. This trip was taken at the instance of a holder of some vacant land at that place, who had offered the same for the building of contemplated institutions which were to form the nucleus to a town. This town, Mr. Dowie had for a long time previous been contemplating.

The site consisted of 120 acres, a block of five acres of which, was to be presented to Mr. Dowie by the owner to launch the enterprise. The advisability of accepting the offer of the real estate owner depended however on the character of the author's report on the suitableness of the territory as a town site.

After spending a few hours in examining the land and its surroundings the author was led to come to an adverse decision, because of some plainly existing engineering difficulties, and the apparent unsanitary conditions that would quite likely obtain, should the locality become a town site. This project was at once abandoned.

Closely succeeding this, another and larger site near the village of Blue Island, Illinois, was offered by other parties. Examinations were made, and for reasons similar to the former, a second adverse report was rendered.

Immediately following this, a beautiful tract of 550 acres of land lying about two miles to the Southwest of Blue Island was offered, and again examinations were made, which resulted in a favorable report regarding its adaptability as a town site, and which caused the interested parties to enter into agreeable terms for the sale and transfer. Pending the examination and perfecting of the title, surveys were commenced, but at the end of about thirty days, a third party having an undiscovered interest in the land, came forward and prevented the would-be grantors from executing the deeds and, therefore, this deal was ended.

Sites near Tolleston, Clanricard, Ill., and Monmence, Indiana, were afterwards examined and reported adversely upon. It began to be quite evident by this time (1897) that no land within a reasonable distance from Chicago, of extensive acreage in one body, belonging to one, and even as many as three or four individuals, was likely to be desirable for the purpose sought. The existence of these three conditions in every case clearly proved the land to be worthless for general farming purposes, and therefore it had never been subdivided into farms of the ordinary size.

Instead of entertaining further offers from real estate owners or dealers, whose number was constantly increasing, and the persistency of some of which were becoming obnoxious, another, and evidently wiser plan was adopted. Attention was directed toward desirable teritory, regardless of occupancy or ownership. Proceeding along these new lines, four or five locations were considered, and the year 1899 found conditions fully ripe for a selection. The growth of the constituency which lay behind this enterprise, had reached such proportions as to warrant the founder in believing that from 6,000 to 10,000 acres would be none too small for the undertaking at hand.

Of the five sites then under consideration, the first choice lay with the territory about half way between Waukegan, Lake Co., Illinois, and Kenosha, Wisconsin. The second site being west of Chicago. Both sites were examined, barometrically surveyed, and reported upon as being favorable locations. Greatest favor was shown, however, to the site north of Waukegan. No other known location was quite so well adapted for the purpose for which it was sought, and it was shortly decided to attempt to acquire it. The choice was entirely unknown to the owners of the land; in fact, they did not realize what had been going on until the property had been acquired.

An excellent agent was chosen to make the purchase, and the labors of doing so began in September, 1899. At the end of three months, nearly ten square miles of splendid territory with scarcely a break had been bargained for, and earnest-money advanced to bind all the contracts entered into.

This now brings us to January, 1900, when activities along the engineering line began. Prior to this nothing had been accomplished in the line of design, except to draw plans for a future harbor.

In almost every other city built, there was first a nucleus. About this other buildings and residences were added, until the winding country road became the main street. Other streets were added when and where needed, at first, without a definite plan. It was only after a start was made that the ground was "platted" for a village. This plat necessarily followed the undirected steps already taken. As the city grows, "additions" are platted and opened for sale, each following in its designs, the existing conditions, the city ordinances, and the will of the real estate dealer who opens it.

Thus is built up a "patchwork" city until it becomes large enough for electric lights, gas-works, water-works, sewer system, street paving, telephone and telegraph systems, and other improvements. No proper provision for these having been made during the growth of the place, they are patched into the patchwork at an expense, inconvenience, and annoyance which might have been avoided had proper provision been made in the beginning.

There were three principal factors that controlled the design of the city, the first two of which were made by the General Overseer in 1899. They were as follows; (1), the location of the Temple Site to be surrounded by about 200 acres of land in the form of a square; (2), Radiating from this center there were to be eight important thoroughfares, four of which were to run with the points of the compass, and four diagonally; (3), The disposition of the storm-water and sewage, were matters to be settled by the Engineer, and they were the next factors to demand attention. The first problem was, therefore, to determine a location as central as possible, which would be suitable for the contemplated Temple. After two days reconnoisance a favorable point was determined upon, lying about 400 feet east, and 70 feet north of the center of Section 21, T. 46 N., R. 12., in Benton Township, Lake Co., Illinois, and which is marked on all maps of the territory subsequently made.

TAKING THE TOPOGRAPHY.

An Engineering Corps was put to work taking the topography of the land, for the purpose chiefly, of ascertaining elevations. The entire territory was divided into squares by lines, 200 ft. apart; levels were taken at each intersection, and note was made of the general topography relating to, and locating streams, farm-lines, roads, orchards, forests, farm-houses, barns and the like. By the ordinary method a corps of not less than four men to run the lines and mark the intersections, followed by another corps of levelers to take elevations, would have been required. The author devised a method whereby three men could do the work. The equipment consisted of, 18″ Wye Level, 1 Philadelphia rod, 1 tape 100 ft. long, 5 flagpoles, 20 to 30 marking pins, a number of strips of white muslin about 1 in. wide 12 in. long, an ordinary 28 in. bicycle wheel fitted with a handle.

The first act was to "tag out" a section, by using the tape and the muslin tags. Beginning at the Southeast corner of a section, measurement was made north to the northeast corner, returning and measuring from the same corner west to the southwest corner, continuing from the southwest corner to the northwest corner. Tags were tied on the fences every 200 feet. Thus the section lines were divided into 200 ft. lengths. The lines running East and West joining corresponding division points were numbered 2, 4, 6, etc. to indicate their distance from the south section line in 100 ft. stations. Similarly the lines running north and south were numbered a, b, c, to z^2. To facilitate lining the quarter section lines were also "tagged."

The next operation was to range in a line of poles on "tagline" 10 or 12, which was the line paralleling the south line of the section and so many hundred feet from it. This could be done quite readily by two men taking advantageous positions approximately on the line, and then correcting each other. After this, the level, the rod, and the wheel were brought into use. As line 0, which was the South line of any section, had already been marked, the levelman and rodman could begin work at once.

The "Man with the Wheel" began at Station B0, which was 200 feet west of the southeast corner of the section. Facing the north and squaring himself with the south section line, which was almost always marked by a fence or a road, he noted some point, tree or prominent object in sight and some distance away, in the direction of the line he was to measure. With eye fixed upon the object taken, he proceeded to walk northward on line B, counting the turns of the wheel as he went. Counting the turns of the wheel was accomplished by noting a red rag which was tied to the rim of the wheel. The wheelman found himself obliged make his counts audibly because he was performing two very distinct operations simultaneously, *running a line and measuring it*. The operator rolled off 200 feet with the wheel and stuck a pin, from which point he repeated the same operation marking off six intersections which reached to the line of flags. He would then return to line C0, and repeat the operation on line C, and so on through the section. After he became experienced, instead of returning to the base line to begin each operation, he would sometimes roll off 200 feet from the north end, and return to the base line, measuring as he came on the next row of intersections to the west, marking the points as he went, The levelers followed the wheelman taking the elevations of the points marked.

It can readily be seen that the only error that could be of any serious consequence, would result from the failure of the wheelman to keep in line. It was the intention, however, to get only within 10 feet of the exact location of any intersection where the ground was fairly level; but in very broken and uneven territory more care on the part of both the wheelman and the levelman was required, and some extra precautions were frequently resorted to, in order that no excessive error should at any place creep into the work.

About ten square miles were successfully taken in this manner, and the method proved to be even more successful than was at first anticipated.

The work of taking the topography, occupied 75½ days actual time, the first two months of which, were attended with considerable severe weather. From the notes of this survey, two topographic maps were made; the first showing the relief in contours, and the second, the general topography heretofore noted, and the elevation of every intersection taken.

THE SURVEYS.

The next work at hand was to begin surveys of the territory to prepare it for subdivision. This is now being done, taking a section at a time making section and quarter-section lines, base lines for the subdivision which will follow.

The field corps consists of one field engineer in charge, one transitman, two chainmen and one flagman. A standardized tape is used with spring balance and thermometers. The compensations for the variations caused by the temperature and for sag are computed, and the measurements are taken by "bobbing," that is, by using the plumb bob at both ends of the tape. When the original section corners have been found or determined they are marked by a 1⅛" square iron bar 4 feet long; while all of the quarter corners and also the centers are marked with ⅞" bars also 4 feet long. All street intersections will be marked with ⅞" square bars, the same as quarter corners. The angles at all Government corners are taken, and the lines radiating from such points are checked to a flag pole 100 ft. high now standing at the center of the 200 acre reserve.

Every base line is measured twice, and the limit of error permitted in any mile is .15 of a foot. Beginning at the three easterly Government corners of a section, and running westerly on the surveyed lines, are placed, 16 inch oak staves driven even with the top of the ground; 100 ft. apart. These are marked nicely both for measurement and alignment. The same is done on the section and quarter lines running north and south. These markings are made for the future convenience of the field engineer in dividing and subdividing the land, and to assist him in checking out his work.

When the survey of a section is completed, the field engineer forwards to headquarters a full report of the result of his work, which is at once recorded and the report carefully filed.

DESIGNING.

Shortly after the topographic maps had been completed, the work at headquarters of making a general design for the blocking up of territory was commenced.

Before outlining the method of making this design, it is necessary to say something of the features proposed in the laying out of the city. Soon after the author's engagement to become Engineer in Chief of this work, he decided to obtain the opinions of prominent city officers throughout the United States on points touching the ideal sizes of lots, widths of streets, widths of alleys and the like. A list of eighteen questions were sent to the Presidents of the Boards of Public Works of 112 cities having more than 12,000 inhabitants, with the result that forty-two very clear and excellent answers were received.

From observation the author came to the conclusion long ago, that the middle of improved streets or highways is not the place for the installation of sewer services, water mains, gas mains and the like, nor should the margins of streets be made to look ugly by telegraph poles. Our eastern cities, do not know the meaning of the word "alley," and can hardly understand of what use it is; while the Western cities, having improved upon this old-fashioned way of laying out towns, introduced this decidedly needed and much used thoroughfare. However, the alley of the West has never been put to the fullest use for which it was intended; its sphere should be enlarged; in it should be placed the subterranean services and the unsightly telegraph poles.

The author recently listened to the reading of a paper, on the subject of "Street Paving," which, among other things, recorded that the greatest destruction to pavements was *not* generally caused by the ordinary wear and tear of traffic, but by the wholesale destruction meted out to them by repairing gangs plying their work in installing or repairing the various underground services laid beneath.

The report of the Department of Public Works of the City of New York, for 1896 shows, that for every mile of paved streets within her limits, there was one-quarter of a mile of trench made during that year, either for construction purposes or in repairing mains; and in addition to this there were 59,000 separate openings made, requiring repairs to the pavements, which amounted to an opening for every thirty-five lineal feet.

It has been the purpose of the author to inaugerate this reform in making the design of the City of Zion. So far as it can possibly be done, every known service both underground and otherwise will be relegated to the alleys. This will require wider alleys than those commonly laid out in the Central and Western States; twenty-five feet has been decided upon as minimum, and such alleys as shall contain trunk sewers must come within the maximum of 35 feet. Alleys of the widths named are calculated to contain such services as sewer-pipes, gas mains, water mains, telephone conduits or poles, telegraph conduits or poles, hot water mains from central heating plants, electric light conduits or poles. The conduits are intended to be side by side; the width of the alleys being such that the foundations of contiguous barns or buildings will not be endangered in the trenching. In the manufacturing districts the width will be that of ordinary streets, in order to accommodate three lines of railroad track in addition to the other services.

The paramount problem in the design of the city, can be seen to be that of economically conducting the sewage from the remotest territory to a point of disposal without interfering with a sensible economy in the fixation of the streets, lots, and alleys. The problem was therefore, to locate the alleys that they might take a direction consistent with the natural lay of the land with reference to the drainage, and avoid locating any alley for which an adequate drainage outlet could not be economically secured. The following are the principal features ntering into the design:—

Width of Boulevards	300 ft.
Width of the four Diagonal Avenues	150 "
Width of N. and S. Streets	66 "
Width of E. and W. Streets not having frontage of lots on them	60 "
Width of Business Streets	80 "
Width of Alleys	25 ft. to 35 ft.
Depths of lots fronting the Boulevards, with 75′ building line	200 "
Depths of Business Lots about	130 "
Depths of Residence Lots aobut	145 "
with a minimum depth of 135′	
The Frontage of the Boulevard Lots to be made as near as possible	100 "
Middle class Residence Lots	50 "
and a frontage of 40 ft. for the cheaper properties.	

Lots will be fixed with their long dimension lying East and west, so far as possible, so that the sunlight may fall upon three of the sides of the buildings sometime during the day; streets, carrying the frontages will, therefore, lie largely in the north and south direction.

Such land as is not usuable for ordinary occupancy, because of its topographical features, will be utilized almost wholly for parks. Two very beautiful ravines invade the outskirts of the territory, one on the north and one on the south margin of the land; and aside from these, other verdant glades and coppices will also be reserved for the pleasant breathing places, so much needed, and so greatly enjoyed by the inhabitants of any town or city.

In the design a boulevard has been placed on the bluff which lies just west of, and parallel to the Chicago & North Western R. R. This is somewhat serpentine in its course, and is continued midway between the principal center of the city and the margin or the outskirts of the land entirely encircling the larger and principal portion of the city. The width of this particular boulevard will be 80 feet.

The 200 acre reserve will be the location of a large temple, institutions of learning and benevolence, and be used for park purposes generally. The part of the land selected upon which it is intended to locate all manufacturies, lies wholly each of the Chicago & Northwestern R. R. tracks, and extends to the lake. This portion of the land lies at an elevation of from 0 feet to 22 feet above Lake Michigan. The floor of the first factory building is at the elevation of 10 feet.

The character of the territory lying west of the railroad is finely undulating, rising from an elevation of 32 feet, which is about the height of the bluff heretofore mentioned, to an extreme elevation of 175 feet in the southwest region of the land; the great body of the land, however, lying at an average elevation of from 60 feet to 120 feet.

The clay is a pure glacial drift; it is capped with an excellent soil except on a few of the more prominent knolls. The highest points in the territory lie in the western portion of the land, and mark the middle of the vast moraine, which extends from the bluff near the railroad to the lowlands of the Desplaines valley, about seven miles West.

An artesian well is now being drilled in Section 22, one mile from the lake front. The drilling commenced in a sandy soil, 12 feet above datum and the rock was struck at 113 feet. A depth of 1500 feet is calculated upon, the work extending into the Potsdam sandstone; and a flow of 400 gallons per minute is expected, with a possible static pressure of from 40 to 60 lbs. per square inch. It is intended that this supply shall be sufficient for the manufacturies in that immediate neighborhood for some few years to come. Territory for sinking impounding reservoirs for the excess flow from this and other wells has been provided for in nearby territory.

Sand of the very best quality abounds on the lake shore and on some of the more prominent ridges nearer the railroad. There is also much shingle of all grades, from the size of a pea to stone as large as a fist. For roofing purposes it will *par excellent.*

A single test of the clay has been made from two different locations, to determine its value for brickmaking purposes. An ordinary clay or buff colored brick was produced, and the author reported that the probabilities were favorable to a still better grade than the test produced, when the operator of the kilns could have some experience in burning the clay.

It is intended to erect a central power plant on the block directly North of that on which the artesian well is located; in this will be installed large power units, from time to time, as the demand requires it. Electrical transmission will be adopted. Electricity will also be used for lighting, and the exhaust steam from the engines will be utilized largely in heating water to supply heat for the buildings in the immediate territory.

The author is investigating the matter of sewage disposal, paying special attention to the septic tank treatment, because he has had a crude septic tank in operation at his private dwelling for about eleven years. Further than this there has been nothing done on the question of sewage disposal; other than that there is in view the use of bacteria beds for the further purification of the effluent, turning it to some account in propogating the growth of the grass, shrubbery, and trees in the large park, which will probably be made at the lake front end of the East boulevard.

The method of making the design of the city was as follows:

A black print of the contours was first placed on the draughting table; upon this was laid a very tough quality of tracing paper susceptible of withstanding many erasures. On this tracing paper the desgn was made, the topography of the whole territory being in plain view. A second contour map was spread on another table immediately at the elbow of the draughtsman, on which he might sketch and make notations as he pursued the study. The work began by first laying out the location of the public grounds around the temple site. The boulevards and diagonal avenues were next fixed. The location of the railroad was drawn, and this completed the arbitrary features already determined. Section 21 was then laid out, apportioning the land not covered by the grounds, boulevards and avenues already fixed; noting continually the relation of the contours to the position of any and every alley, and the effect this position would have on the economical construction and prospective outlet of the sewer such alley would necessarily be required to accomodate.

Watersheds were dotted on the paper, also the general course and trend of the natural outlet for the drainage; so that this might be kept constantly in mind and in sight, and that no alley would be laid out which could not have traced from it an outlet for drainage capable of economical construction. Small arrow-heads were placed in the alley of each block to enable the eye to detect easily the direction the drainage would take; and when a section of territory came under the study of the draughtsman that would not permit of laying the alleys out in regular manner because of impossible drainage, a counsel was called and the situation was studied thoroughly, and an effective design acomplished. No blocking has been designed that will not provide every lot in the city with an alley. No alley has been laid without knowing exactly the course and route the drainage from it will take, and the ultimate point to which the storm water or sewage will flow.

DISCUSSION.

MR. J. H. BURNHAM: The speaker understands that an artificial harbor is to be constructed and he expected to hear something about this. It would be interesting to hear something of its construction as well as of the contemplated factories.

A parallel to this undertaking was the beginning of the city of Navoo. The city of Lawell, Mass., was laid out as a manufacturing city by the engineers. The city of Washington was planned and laid out by engineers. There are, however, only few instances of cities being designed by engineers and carried through.

MR. B. J. ASHLEY: The industry of lace making will claim attention at first. The interest of Samuel Stevenson of England has been purchased, and a building is being built for this; it is 500 ft. long and about 102 ft. wide inside and two stories high. The south half of this building will be devoted to lace making and the north half to curtain making. Eight machines will be put in and work begun. Another building is now being constructed. It is a temporary frame structure and the permanent building will be built over this later.

The lace industry will occupy one row of blocks. It is intended to put in woolen, cotton, and linen industries later; however that is not yet fully developed. There are also indications of a large boot and shoe manufactory coming from Boston.

The harbor will require two piers about 1000 ft. long. It will have to be dredged to a depth of about 20 ft. The width will be about 300 ft., and since there is no stream the whole harbor must be made by dredging.

The method of taking the topography was adopted because it appeared the cheapest for this tract. It was more accurate than if the distances had been paced and no more expensive. The tract was limited so that the full value of the stadia could not have been developed.

MR. A. W. ALVORD: For surveys of this character the cross section method, as used, is the cheapest. The speaker had occasion to compare this with the stadia method in a survey of Jackson Park, Chicago, made before the World's Fair. The stadia had a little advantage in the wooded portions, but in the open the other method was more rapid. In this survey distances were measured by pacing, and it was noticeable that the men took much shorter steps toward evening than in the morning thus producing some errors.

PROF. M. S. KETCHUM: The reason that the stadia method does not prove satisfactory sometimes, is because of the difficulty to get instrument men who are familiar with the work. It takes an expert man at the instrument to get good stadia notes, and the results obtained by men who have had no experience in this work are often worthless.

DISCUSSION.

What Legislation is needed to secure Legal Reports from all Drainage and Lever Districts?

MR. J. H. BURNHAM: The speaker suggested this question. The subject is very important; millions of dollars have been spent in drainage districts, and many millions more are to be expended.

The districts are under the jurisdiction of Commissioners who report to no one; they are the highest authorities in matters relating to land drainage. A great deal of work is being done, but since no systematic reports are made, nothing accurate is known as to its character and amount. This subject is interesting and of importance to engineers and they should have some means of learning of results obtained. The society's committee on this matter has been able to obtain little, if any, information from the commissioners; and the speaker's object in bringing up this question was to bring out whether or not it is possible to have a law enacted which would compel the commissioners to make reports of their work.

Work is now progressing on levees on the same plan and the same statements apply in this case.

MR. P. C. KNIGHT: It would be difficult to get reports from the Drainage Commissioners or Clerks of the Drainage Boards; they are generally farmers, and do not keep very good accounts of their work.

Drainage districts are formed by petition, being authorized by the county courts. Commissioners are elected, and they are supreme in their district; no one has control over them; they make reports to no one. They are their own auditors, accounts being audited at a regular meeting.

PRESIDENT C. C. BROWN: The practice in Indiana might serve as a guide for any legislation. There the Drainage Commissioners are required to make a definite report to the Judge of the Circuit Court, and their reports must all be approved before they can draw their salaries or before work is begun.

MR. W. A. HAY: The drainage district organization referred to, is that of the Township District, which is different from that of the County District. In the speaker's county (De Kalb), after a petition by the property owners, the Highway Commissioners are appointed Special Commissioners, and have charge of all matters relating to the District until the first of March following the appointment. Then a call is issued for an election and three Drainage Commissioners are elected who take charge of drainage matters in much the same way as described by Mr. Knight.

OPEN WATER COURSES FOR LAND DRAINAGE.

BY P. C. KNIGHT.

Where natural water courses do not exist, the land is of little value for agricultural purposes. Generally marshes or swamps having no natural drainage, have been found to be the most productive of all land when drained, and advancing civilization has demanded that these be drained artificially. It is the purpose of this paper to give a few facts concerning artificial open water courses.

Formulas for construction of open drains can be found in a few works on Hydraulics; these the author has found to be pretty accurate. Tables are given for pipe drains, but the data for open drains is so meager that some facts which have come under the observation of the author may be of value.

CASE I.

About twenty years ago the owner of a large tract of marsh land, through which flowed the run-off of about 170,000 acres, began the construction of a ditch to form a channel for the water. Before this time it flowed over the whole surface of the bottom of the valley which was about a mile wide. He commenced at the upper end of his land, and when he had cut the channel about one and one-half miles, or about half of the length of his tract, owners of land farther down the valley obtained an injunction restraining him from cutting the ditch any farther. Why he did not have the injunction dissolved the author cannot say, but the fact is the construction of the ditch was abandoned. The natural fall of these three miles of bottom was 15.3 feet, very evenly distributed. This bottom is composed of a sandy loam about three feet deep, with a sandy clay subsoil. It was not many years before the water had worn quite a large channel, cutting away the banks of material deposited in constructing the ditch. About seven years ago the land was sold. The parties who bought it opened up the channel the full length of the land, below which there now had been constructed a channel. The whole channel is now about 65 feet wide at the bottom, and about 75 feet at the top, having a depth of about 7 feet. There is now no overflow of the land and the water at all times remains within the channel, the highest flood only filling it full.

In constructing channels under these conditions very little dependence can be placed in the banks composed of the excavated material, it being easily washed away by the flood water. There is proof of this about three miles farther down in this same bottom where, about eight years ago, there was constructed a channel to carry the run-off from about 200,000 acres. This channel had a bottom width of 40 feet, and a berm of 10 feet; the excavated material was deposited on each side, the intention being that it should form a part of the channel for carrying the flood water. These banks are now nearly swept away because the excavated channel was not large enough. Some of the material was deposited in the channel. The fall is only about 2.5 feet per mile, and is not enough to clear the channel of the sand of which the soil and subsoil and therefore the banks are partly composed; therefore it has settled in the bottom to a depth of one and two feet. This shows plainly that the channel should have been cut with a greater bottom width. It might be said that the engineer of this ditch was a lawyer. The bottom land is now insufficiently drained and is badly overflowed during high water. When the channel is enlarged to proper size, it will be necessary to move the remainder of the banks deposited during the first construction.

CASE 2.

About six years ago the author was called upon to plan a drainage system for about 4,000 acres of swamp land. The main ditch was required to carry the water from a valley about 2 miles wide, and six miles long, making the total drainage area a little over 7,000 acres. The upper two miles of this ditch was constructed with a bottom width of 4 feet and a side slope of 1½ to 1; in the middle two miles it was given a bottom width of 5 feet with the same slope; and in the lower two miles a bottom width of 6 feet also with a side slope of 1½ to 1. The average depth through the lowest ground was about 4½ feet. The natural fall was small, being only a little over six feet in the whole length. The ditch was given a fall of .02 foot per 100 feet. The excavated material was deposited on each side, forming a bank in the low ground about 1½ feet high.

The summit of the divide surrounding this valley was about 20 feet higher than the bottom or swamp land. The surface descended from this divide to the bottom in about half a mile, although in some places it was in less than a quarter of a mile; so that the run-off was a great deal more for a given time than it would have been had the whole been fairly level land. It was not absolutely necessary to have cut the ditch 4 or 5 feet wide in the bottom near the upper part of the valley; but narrow ditches soon fill to some extent by action of water and frost so that it is well to cut them a little larger.

The soil of this compact little valley is a clay loam which underdrains fairly well. The action of the water on the banks is not nearly as great as it is in Case 1 and the cross-section of the ditch has remained fairly fixed since its construction. The high water has never overflowed the banks; in fact, there never has been at any time more than enough water to fill the excavated channel. If it were not that there is always a gradual filling up of such ditches, this one could have been cut a little smaller; but if ditches are cut to just the proper size, the debris settling in them soon necessitates cleaning out.

DISCUSSION.

PROF. A. N. TALBOT: It is important to know the amount of water that reaches these ditches at the time of high water and at the time of ordinary flow. Very little data is given on this. One reason why so little is known about the discharging capacity of these ditches is that it is difficult to measure the quantity of water flowing at any time. This is because the straight portions of the ditches are so short, the cross-section is not uniform throughout these short reaches, and the amount of fall is so small that slight errors in measurements would seriously effect results.

Some measurements of discharge of drainage ditches have been made under the direction of the speaker. It was found that for the larger ditches n is about .025 in Kutler's formula and for the smaller ones n is about .030.

MR. P. C. KNIGHT: In the cases given in the paper the run-off was about ¾ in. in 24 hours at times of high water and about ½ in. at times of ordinary flow.

REPORT OF THE COMMITEE ON DRAINAGE.

To the Members of the Illinois Society of Engineers and Surveyors:

GENTLEMEN: All the information which the Committee has been able to obtain in regard to the drainage work in the State during the past season, is that it suffered the same depression which other lines of business did during the heated presidential campaign; and that probably 10% or 15% less work was done than in the preceding year.

The contract for the work in the Big Four district in Ford Co. was let. Three dredges were erected and from 30% to 35% of the work done, with a fair prospect of completing it by the 1st of Sept. next.

This being the extent of information received. No attempt will be made to further review the drainage work; but instead, as has been suggested by some members of the Society, and requested by others, some suggestions in regard to the size of drains will be given, together with a brief discussion of the common methods of Commissioners in classifying lands in regard to the benefits to be derived.

In large drainage districts, where large open drains are required, and the country is nearly level, an outlet channel is recommended that will carry one-tenth of the flood flow as found by the formula of J. T. Fanning, $Q = M5/6 \times 200$, in which Q is the volume of discharge in cubic feet per second and M is the square miles of watershed. If the watershed is quite rolling, this may have to be increased to one-sixth.

As the size of the ditch is a very important matter, it should not be hastily determined. The *special* topography of the watershed has very much to do with the question. Two districts of equal watersheds with very similiar *general* topography having ditches of the same size with the same grade frequently furnish the proof that in one case the ditch is needlessly large, and in the other ruinously small. If the fall from the divide to the ditch be much greater at the lower than at the upper end of the watershed, a much smaller ditch is required than if the reverse be true. In the first instance the water from the lower end reaches the drain and is carried off before the water from the upper end is brought down; and in the latter case all the flood waters of the watershed may reach the drain at lower end at the same time. If the greatest or least fall from divide to ditch be in the center of watershed the change in size of section may be made at points different from those for ordinary conditions to secure immunity from overflow and at the same time economy in construction.

For tile drains the above is only applicable where large basins are drained; and where the water in the basin has no means of escape except through the tile.

Ordinarily the farmer has, by successive plowings, made openings through the crest of all the smaller basins; and if a tile has a *perfect outlet* floods affect it but very little, as the flood waters reach the outlet over the surface and independent of the tile. It is true that it may at times seem overcharged and the ground get perfectly saturated, but it very rarely continues so long enough to materially injure a crop. Fanning gives for such areas as are generally found in these sub-districts,—they very rarely exceed two square miles—the mean flow as only one-two-hundredth of the flood flow; and experience has proven that this is about the amount of discharge to provide for. As in open drains the *special* topography must decide the exact size but the experience of the chairman has invariably shown the discharge to be between one-half and one and one-half cubic feet, generally one cubic foot, per mile per second. In very level tracts, where the surface water moves very slowly, this has at times seemed insufficient; but if a crop is flooded for twenty-four hours, even in most trying weather, but very little injury is done;

and if the water is continually changing depth, either rising or falling, two or three days seldom destroys a crop. The fact that a flooded crop will live two or three times as long where the water is changing depth as when it is stationary has often been observed but cannot be explained.

These very wet seasons come very rarely, probably not averaging once in ten years, and the point for the engineer to consider is, which is the greater loss to the farmer the damage to, or loss of a crop once in ten years or the interest for ten years on the increased price of larger drains.

There need be no fear of slight grades. A tile laid nearly level gives nearly as good results as steeper grades. A tile, laid level for a mile, with its upper end three feet deep, has a head of three feet, as far as the safety of the crop or volume of discharge is concerned.

In 1894 the chairman planned a system of tiling which carries the water of about 1,200 acres and consisted of almost seven miles of tile. With the exception of 700 ft. on the extreme upper end the fall is eight-tenths of a foot to the mile. In 1884 he planned some work for a smaller tract and the tile was laid level. Both of these systems are still working successfully.

Commissioners, in classifying lands, generally assess the dominant lands "for taking care of their water" and the servient lands according to the amount of *wet* land upon them. This is so fundamentally wrong that it is not surprising that such better litigation as only drainage districts seem to engage in, ensues. The water from the high land must necessarily pass over the servient land; and the owner, if he should hinder or prevent this, is liable to an action of tresspass. So, when the Commissioners or Courts tell him that if he does not allow the water to flow in its natural course, they will mulct him in damage, and if he does not allow it, they will mulct still worse, he at once justly says "it is nothing but downright robbery." He immediately jumps at the conclusion that he is intentionally being wronged, and bitter fight ensues. The land in all probability, ought to be taxed, not for carrying the water, but for the benefit derived. This benefit may be the improvement of contiguous property, improved sanitation, the lessened danger to crops or stock by prairie fires, the opening of new markets, and the furnishing of better social and educational advantages by improving the means of communication. But whatever the benefit consists of whether one or part or all of those mentioned, it should be stated; and in nine-tenths of the cases this will remove all the bitterness and produce confidence in the honesty of purpose on the part of the Commissioner. Honest differences of opinion as to the *kind* or *amount* of benefit will arise, but if there is no ill will they can in most cases be amicably adjusted.

The existing conditions are best shown by an example. In a marsh, A and B have equal tracts of land each bordering on a proposed ditch, and each equally flooded, and alike worthless for tillage and nearly so for pasturage. C has a tract on what is usually called, an island, from the fact that six months in the year it actually is such, but it is perfectly drained by Nature. A and B are usually classified as 100, representing the greatest benefit and C is classified at either 0 or perhaps 5; the usual "carrying the water" idea being seemingly forgotten in these small tracts of high land. The ditch is constructed and the whole district drained. A's land proves a rich, deep loam and is at once cheap at $80.00 per acre. B's land proves a barren sand field which, instead of being simply worthless, has become a nuisance as nothing but sand burrs will grow on it. C's land by being made accessible has jumped to double, triple or quadruple its former value. Yet B pays as much as A and C pays practically nothing. This is no overdrawn illustration. In large districts, when the lands are separated several miles, these conditions are often found. Certainly no one can claim that such classifications are just; and the worst feature is the great trouble to show to either judge or jury the injustice until the work is done, and the classification irrevocably fixed.

The question which Commissioners should keep constantly before them in classifying is, "what is the land worth now and what will it be worth when the ditch is completed?" This difference is the true basis for classification. However the man who can intelligently answer this question has for higher attainments then has the average Commissioner and there is still enough opening for trouble. This matter of classification, together with a too free exercise of the almost unlimited power of the Commissioners to expand the district is the cause of fully nine-tenths of the litigation which begins at the birth and ends with the death of a drainage district. A litigant in the Big Four district lately told the chairman that the district had already paid $10,000.00 for counsel fees. He did not say what his side had paid, but probably a like amount. He further said that he thought the litigation only fairly started, certainly not half through. This would make the entire cost of the litigation about $25,000.00 to date or 20% of the estimated cost of the entire work. How much better for the district if this could have been spent in the supplementary work of underdraining.

The chairman for the last eighteen years has been almost constantly associated with drainage districts, and has seen much of the litigation attending them. He is of the opinion that the courts, under the plea of public policy, lean altogether too strongly in favor of the district. If in passing on disputed points, more regard were paid to the equity of the case and less to the strict letter of the law, it would prove in the end beneficial to the cause of drainage. In the case given as an illustration the latter policy might cause delay or even defeat, but it would ultimately result in wiping out the methods by which so great injustice is often wrought.

Some litigation must be expected, for some people are born litigants. There will always be some who think their benefits rated too high and their neighbors' too low; such cases must be decided by the courts. Litigation is necessarily begun by some action of the Commissioners, who, however honest, are only human, and therefore liable to err. However the courts very rarely materially disturb their action and still more rarely overthrow it, and people are apt to think there is something radically wrong, either in the letter of the law or in its application. This belief is doing more towards preventing the formation of new districts than any other one cause. The mistakes of one district, especially when they have been upheld by the courts, make the most efficient weapon which the opposers to the next wield. The saying, "You may as well try to beat Death, as a drainage district," has almost become an aphorism, and is doing the cause of drainage much harm. Drainage districts should, in the interest of drainage, be upheld when in the right, and be beaten when in the wrong.

This matter has not been discussed in this report because engineers have much to do with it in the outset, for indeed they do not, but in hopes that when called upon in the adjustment either as engineers for the districts, consulting engineers, or expert witnesses, they will bend every energy toward a perfectly equitable adjustment.

Large tracts in our river bottoms are awaiting reclamation simply because people hesitate to organize under a law which they fear leaves them "no rights reserved;" and it is hoped that every engineer will endeavor to have the law shown of its abuses and administered with the impartial fairness which its framers intended. There is already an improvement in this respect, Commissioners are rising to a higher sense of their responsibility; their counsel, on whom they rely so much, by the frequent airing of these questions in court, is obtaining a better insight into the principles of drainage and is better enabled to advise broader and more circumspect action. The opposing counsel, with knowledge gained in the same way is enabled with increased skill to determine and strike the vulnerable points of his opponent. The result of this course of action is such that it is already evident that the work of reclaiming our vast marshes, will soon be begun in earnest.

J. L. CLARK,
JOHN ZETER,
P. C. KNIGHT,
Committee.

REPORT OF THE COMMITTEE ON SEWERS.

To the Members of the Illinois Society of Engineers and Surveyors:

GENTLEMEN: The report of the Committee on sewers is brief because the data upon sewers solicited from members and received has been limited. The bulk of information shows that throughout the state a large amount of pipe sewer has been constructed; but no special features attending their construction have been indicated.

The sewer built by the city of Moline last spring presents some novel features. The location of the sewer close beside the old retaining wall of a tailrace, with a consequent large seepage, on one side, and a railroad embankment on the other; a cover of 20 feet and over; and the delivery of regular and storm water into the excavation made the design and construction difficult. The cross-section adopted was circular, six feet in diameter. The sewer was built of Griffin blocks; so that it was composed of segments. These blocks being hollow, provided drainage for the trench under ordinary conditions. It was found that the unequal loading of the sewer caused a settlement of the arch. To correct this and to provide against future trouble, a lining of a single course of brick was built. The diameter of the sewer was, of course, reduced nine inches; but on account of the ample allowance for over load, it is believed that the sewer will not be overtaxed at any time.

The committee would urge the Society to take the initiative at its next annual meeting, in obtaining legislation for the creation of a state commissiuon which would pass upon public improvements, in which sewerage systems and sewage disposal would be included. The President, Mr. C. C. Brown, in a paper before the society last year, most ably discussed the need for a public works commission which would have sewerage, water supply, etc., under its jurisdiction. The wonderful growth of this state, as evidenced by the census of 1900, shows that we can not afford to delay this matter which has for its object the welfare of the state at large.

J. G. MELLUISH,
JOHN C. QUADE,
CHAS. P. CHASE,
Committee.

PROPOSED TOPOGRAPHIC MAP OF ILLINOIS.

TO BE MADE IN CO-OPERATION WITH THE U. S. GEOLOGICAL SURVEY.

By W. H. Herron.

AVAILABLE MATERIAL.

It is a matter of surprise that the state should have been so slow to grasp the idea of the importance of utilizing the advantages offered by the various engineering and scientific organizations of this country, who have published the results of years of earnest effort and thought, and incorporating them in a state map.

The U. S. Coast and Geodetic Survey has crossed the south central portion of the State in extending westward their transcontinental scheme of triangulation.

The U. S. Lake Survey has connected the survey of the Great Lakes with this work by an extension from Lake Michigan.

The Mississippi River Commission has, in the accurate mapping of the Mississippi River, carried triangulation along the entire western boundary of the State.

All this work is of great refinement and is available for the base work of a State survey of whatever degree of accuracy, and means a saving of vast expenditure.

The U. S. Geological Survey has mapped with much accuracy an extensive area of country reaching from Chicago almost to Peoria; these maps have been published and afford an interesting comparison with any others extant of this same region.

It is a lamentable fact that no maps are in existence to-day covering any large portion of the State which are at all sufficient for the requirements of our people.

WORK IN OTHER STATES.

It is safe to say that, outside of the United States, there does not exist an equal area of land inhabited by people at all comparable in numbers or civilization, which has not possessed for years maps of far greater refinement than any we possess of the State of Illinois. Nor have we kept pace with many of our sister States in this matter.

New Jersey, in conjunction with the U. S. Geological Survey, completed a topographic map of the State in 1887, which was begun in 1877.

Massachusetts under similar arrangements mapped the State during the years 1884 to 1888.

Rhode Island, in the years 1888 and 1889, was mapped in a similar manner.

Connecticut with like arrangements was mapped in 1889 and 1890.

New York has been likewise engaged for a number of years and is utilizing its present opportunities to complete a map of the State at an early date.

Pennsylvania has recently taken up this plan and has just completed the first year's work on the co-operative system.

The last Legislature of the State of Ohio provided Twenty-five thousand dollars for the first year's co-operative work in that State.

GENERAL SCOPE OF A TOPOGRAPHIC SURVEY.

A topographic survey notes all natural features of the earth's surface; it measures altitudes and depressions and their angle of slope, in addition to the usual measurements for distance and directions. From these notes, by a system of contour lines a may is constructed which delineates, in addition to the usual features, the surface configuration, revealing to us an entirely new class of facts of greatest value.

TOPOGRAPHIC WORK OF U. S. GEOLOGICAL SURVEY.

The topographic maps of the U. S. Geological Survey are unusually satisfactory in representing surface forms. This institution from its incipiency realized the necessity of a topographic map to be used as a base for the delineation of areal geology and the topographic work was authorized by Congress to be provided for from the annual appropriation for that bureau. Its topographic methods are described in great detail in "Manual of Topographic Methods" by Henry Gannett, Monograph XXII, U. S. Geological Survey, and by H. M. Wilson, Geographer, in an address before the American Society of Civil Engineers and published in Vol. XXXIII, No. 5, Transactions.

This Survey has progressed with marvelous rapidity during the last fifteen years and pcssesses to-day probably the best methods in use for the prosecution of this class of work.

ECONOMIC VALUE.

The pecuniary advantages of such a map to the State of Illinois are many and varied and appeal directly to nearly all classes of citizens. In his presidential address before the Ohio State Academy of Sciences at Columbus, Ohio, December 29, 1896, on "A Topographic Survey of Ohio," Professor Albert A. Wright said:

"If the scale of the maps was such as to permit the country roads and streams to be designated, as it ought to be, then they would lend themselves to a thousand uses of our daily life. At a glance one could locate the steeper slopes and level stretches. The traveler, whether on foot or on wheel, can know the ups and downs of his journey beforehand. The land buyer can bring to book the descriptions of the land seller, seeing for himself what is upland and what is river bottom, delineated by an authority that is entirely impartial. The engineer can lay out the preliminary profile of his turnpike or electric railway at his office desk, being sure of the correctness of the large points of control. City engineers can calculate the water supply that is tributary to their towns, can know at what levels it can be impounded and learn by inspection the most economical location of dams, reservoirs, and pumping stations. The feasibility of projected ship canals and the comparative merits of different routes can be, in great measure, settled without expense. The manufacturer, the miller, the miner, the contractor, can know beforehand the best location for his factory, his mills, his shops, and his headquarters.

"Eventually, the geological outcrops can be transferred to the same maps in a scheme of colors, the geology explaining the topography and the topography suggesting the geology. Then the sheet will be bearing something like the load of correct information concerning the surface of the State that should be demanded and furnished by an intelligent commonwealth."

Professor Wright's statement shows a comprehensive knowledge of the uses of the topographic map and enumerates them with great clearness.

The advantages he mentions appeal to the citizens of Illinois, because of the similarity of topography, physical conditions and environment in the two States.

The work of draining the farm lands of Illinois by tiling could have been performed at much less expense had a topographic map of the State been in existence for the past twenty years.

The subject of good roads in Illinois is only in the beginning of its discussion. It is a problem that must be solved in the near future. A topographic map would materially help in the solution and lessen the cost of construction, especially when reconnaissance surveys are necessary.

A waterway from Lake Michigan to the Gulf of Mexico is a question of great importance to our citizens. It is not difficult to see the necessity for an accurate topographic map of the prospective route.

The draining of swamp lands is still incomplete in portions of the State. An accurate topographic knowledge is necessary in all such work.

The entire area of bottom lands of the Mississippi and Illinois rivers calls for continued improvements for successful cultivation. It is not difficult to note the uses of a topographic map in such instances.

Suburban lines of railways, connecting various cities of the State, will be planned and built for several generations yet to come. Here also a topographic map is necessary.

The problem of water supply for our smaller cities is one constantly before us. We have no maps that give us this information. Preliminary surveys costing thousands of dollars in individual cases will be necessary unless a State map be constructed which will enable us to obtain the necessary information. The entire cost of such a map would be much less than the saving in a few years in this particular line of work.

The advantages of reducing various classes of work and levels to a common datum plane appeal directly to the engineer. With an accurate topographic map based upon a sea level datum, this problem is solved.

It is an easy task to mention numberless private and State enterprises which will be able to use directly the topographic knowledge to be obtained from such a map.

ENDORSEMENTS.

It may be of interest to quote from letters of endorsement which have been voluntarily addressed to the Director of the United States Geological Survey in asking for additional maps or in commenting on those already received, in States where the surveys have been completed and results published.

Chief Engineer Walter Katte of the New York Central Railroad says:

"They are infinitely the most useful small scale topographic maps I have ever seen. With maps like yours a very respectable preliminary location and profile of a railroad route could readily be projected without going into the field at all."

City Engineer R. A. Cairns of Waterbury, Connecticut, writes, asking for the maps, saying:

"They would be of the greatest value to the city of Waterbury at the present moment, as we are seeking a water supply."

Mr. H. M. Wilson, Geographer of that section of the work, in commenting on this letter says:

"I may add that after expending ten thousand dollars in examining two sources of water supplies, Mr. Cairns, from an inspection of these maps, obtained a far better supply which he at once discovered from these maps, and from which the water supply of Waterbury is now derived, the preliminary survey for this present supply having cost not one cent."

Chief Engineer L. A. Hyer of the Washington and Chesapeake Railway Company writes:

"I used your contour maps in the location of this road. Had to re-run but very little of the line and reduced number of curves to 6 from 107, or saving in all 3,266 degrees of curvature, shortening the line 4.7 miles over a line previously located by me without the aid of these maps."

D. B. Banks of Baltimore, Maryland, used these maps in locating a line of suburban railway. He writes:

"Used them extensively in locating the larger part of the preliminary route of the Washington and Baltimore Boulevard and Electric Road."

Chief Engineer A. Fteley of the Croton Aqueduct Commission of New York, says:

"Your maps render unnecessary many of the preliminary surveys essential to our city water supply, highway and other engineering works."

Chief Engineer F. P. Stearns of the State Board of Health of Massachusetts writes:

"These maps are of the greatest assistance in enabling me to make a comprehensive preliminary study of all possible sources of water supply and water pollution. With these maps I make as much progress in preliminary work in a week as I could with the old existing maps in two or three months."

Fortunately, the practical benefits of such maps are not matters of conjecture. In States where the work has been completed either by co-operation or by the federal survey it has been a matter of practical demonstration for a number of years. Commendation has been general on the part of all civil and mining engineers of prominence, geologists, colleges, chambers of commerce and prominent citizens, where the maps are understood. Where the maps exist they are generally used by the public. They have been endorsed in resolution of:

The American Society of Civil Engineers.
The New York Chamber of Commerce.
The New York Academy of Sciences.
The American Geographic Society, etc.

It is not difficult to realize from the foregoing how great would be the pecuniary value to the citizens of Illinois of such a topographic map of the State and how quickly the commonwealth would receive in actual value many times the cost of the map.

EDUCATIONAL VALUE OF A TOPOGRAPHIC MAP.

In addition to the economic considerations for the necessity of this survey, the scientific and educational aspects of the question appeal most strongly to thinking citizens. The study of geography in its various branches has developed with the same rapidity as sister sciences. The old geographies of our early days have become obsolete and the new system of progress in this branch renders such data absolutely necessary. The naturalist, the botanist, the geologist and the meteorologist find such a base map an absolute necessity. The world about us is busily engaged in the solution of problems arising from environments and constantly adding to modern science the results of its study and investigations.

PLANS AND ESTIMATES.

The practical plans for making such a topographic survey and its final cost are easily accessible. The co-operative plan, already adopted in many eastern States and recently in Ohio, appeals most strongly to the economist and to any one who will thoroughly study the subject; it presents a plan thoroughly practical, economical, and feasible because of the years of experience the U. S. Geological Survey has had in this particular work. This organization has spent many years in training a corps of topographers, whose knowledge and skill in this class of work is invaluable. Probably no other organization in the world possesses as perfect a system of topographic field work or has the experience of this institution. It would take years for a new organization to train a corps of men to equal them in proficiency. It is here the State would save so largely in the prosecution of such a survey. By co-operation the State would also be free from practically all cost of administration which in a new organization is comparatively very great.

A bill has been proposed to authorize a topographic survey of the State of Illinois in co-operation with the U. S. Geological Survey. It authorizes the Governor to appoint a commission of three citizens of the State (who are to serve without salary) to confer with the Director or the representative of the U. S. Geological Survey, and to accept its co-operation in the preparation and completion of a contour topographic map of the State. This commission is given power to arrange with the Director or his representative concerning the map, its scale, method of execution, form and all details, in behalf of the State and to accept or reject the work executed by the U. S. Geological Survey. It provides that the map shall accurately show the outlines of all townships, counties, and extensive wooded areas, existing on the ground at the time of the execution of the surveys; the location of all roads, railroads, streams, canals, lakes and rivers; and shall show by contour lines the elevation and depression of the surface of the country. It further provides for the first two years an appropriation on the part of the

State of $20,000 each year, an equivalent amount to be expended by the U. S. Geological Survey, and limits the final cost to the State to $4.00 per square mile. From accurate estimates based upon a similar class of work in other States and taking into consideration the character of the topography in Illinois, we are assured that a map on a scale approximating one mile to the inch (publication scale) can be made for this sum. Illinois has an area of 56,650 square miles, 4,435 square miles of which have already been surveyed, leaving the area to be mapped 52,215 square miles. At $8.00 per square mile, the total cost of the survey would be $417,720. Half of this amount would be expended by the U. S. Geological Survey, leaving $208,860 as the cost to Illinois for a complete topographic map of the State. It would be controlled horizontally by a system of primary triangulation (developed from the various accurate triangulation surveys already made within the State) and by primary traverse, one exact horizontal position in every ten square miles being established. Vertical control is obtained by a system of leveling whose maximum limit of error on main lines would be six inches to 100 miles. In connection with this branch of work, at least one permanent bench mark with elevation marked to nearest foot would be set in each township or equivalent area, and at least one recorded bench mark of less permanent character in every three square miles. A meridian mark would be established at each county seat in the State for the use of local surveyors in testing instruments and establishing exact compass variations. Topographic maps produced by co-operation are engraved on copper and printed from stone in the highest style of cartography, without expense to the State. Transfers from the copper plates may be furnished the State if desired, to print its own edition.

The appropriation from the State would be expended entirely in actual field work, living expenses, and services of temporary employees resident in the State. The appropriation of the federal government would be used partly in field work, partly in salaries of its permanent employees and a small amount toward general administrative expenditures. It will be noticed that the total appropriation of the State is returned to the people of the State, and that about sixty per cent. of the federal appropriation is also expended in the state.

ADVANTAGES TO THE U. S. GEOLOGICAL SURVEY.

The advantages to the United States in co-operation are apparent in the following:

The total appropriation for topographic surveys by the federal government is divided pro rata among the States. That the Federal survey may complete the mapping of the United States, it diverts larger sums to such States as co-operate. It pushes its topographic map by this means in any locality in which it may produce the largest results at least expense to the Government. This is done that the topographic map may be had at the earliest date for further study of economic resources, hydrography, forestry, etc.

THE NECESSITY FOR IMMEDIATE ACTION.

It is hardly necessary to comment further upon the advantage to the State of such an arrangement, nor should we delay action in the matter. For obvious reasons, the Federal survey, on account of limited appropriations, cannot carry out this plan of co-operation in many States simultaneously, and we may be sure that the States surrounding us are already awake to the importance of grasping this opportunity. It is sincerely hoped that the Legislature will take up this proposition early in the session and act upon it speedily. It is incumbent upon every citizen who is interested in the welfare of Illinois to lend his influence and assistance toward hastening the accomplishment of this work.

DISCUSSION.

PROF. M. S. KETCHUM: The speaker is glad that the society has this opportunity to discuss the question of a topographic survey of the state before anything is done in the way of a definite recommendation of the plan. The members of the Society probably know that a survey of the state was made to obtain data for the preparation of a relief map of Illinois for exhibition at the World's Fair. In this survey the horizontal locations were determined from the United States Land Surveys. The vertical control was based on government surveys and railroad profiles checked at intersections and reduced to sea level datum. The contours were sketched in the field; aneroid barometers being used to determine intermediate elevations. The cost of this survey, twenty-five cents per square mile, was certainly very low considering the results that were obtained.

The survey proposed by the United States Geological Survey as described by the author will be very much more accurate than the survey referred to above and will be of inestimable value in making preliminary railways surveys, determining watersheds, locating highways, laying out drainage districts, and for designing drainage in the rolling portions of the state. It would seem, however, that the maps would be of little value for drainage purposes in the level portions of the state like Champaign County, where a difference of a foot in elevation will often determine whether a tract can or cannot be drained.

The proper scale to be used in making a topographic map depends very largely on the character of the surface surveyed. A scale that would be proper for a mountainous state like Colorado would be of little use on the prairies of Illinois. On acount of the difficulty in obtaining long sights both in running the triangulation and traverse skeleton, and in filling in the details with the plane table and stadia, the cost of making a topographic map to any given scale will be more for the prairie than for the mountain state.

The Mississippi River Commission has surveyed a strip along the western part of the state and has mapped it to a scale of 1 : 10,000 at a cost of $51 per square mile. These maps have proved to be of considerable value and a map of the state made to the same scale would certainly be sufficient for all purposes. It is not probable, however, that a survey on this scale can be undertaken for many years to come. In case the state was mapped on a scale of 1 : 10,000 there would still be a demand for a map of the character described by the author.

It would therefore seem best to the speaker to follow the suggestions made by the author and make a topographic map of the state on a scale of 1 : 62,500 at a cost of approximately $8.00 per square mile. The topographic survey should be followed by a survey of the economic geology of the state. The topographic map must be made before a geological survey can be successfully made. In view of the foregoing the speaker wishes to commend the proposed topographic map as described by the author and hopes that Society will give the enterprise its endorsement.

MR. W. H. HERRON: The paper did not touch extensively on the leveling. In the proposed survey permanent bench marks will be established in each township, each accessible so that the system may be extended. The second levels are run by telescopic angles; and often the leveling is with the stadia itself. The speaker believes that the map would be very valuable in the drainage of swamp land.

No barometer methods are used; they have been abandoned by the United States Geological Survey because they were too inaccurate. The first four or five years of the speaker's service were spent in working out and adjusting barometer readings. On the plains of Kansas a system of running vertical angles was adopted. Stations were established at every section corner; and from these the barometer was taken to determine intermedite elevations. The barometer has proved to be entirely unsatisfactory. Gradually it has left the Geological Survey, and few are sorry that it has gone; it is impossible to do accurate work with it.

In taking the topography the plane table is used to a great extent, much of the work being done graphically. If the plane table were not used the cost would be much more. An area that costs $8.00 a square mile would cost several hundred dollars; as it does in England, in fact all Europe is a hundred years behind us. However, maps of the flatter portions of the state would be quite expensive, because more detail would have to be taken and the contour interval must be smaller; yet whatever is done at $8.00 per square mile would not be lost; both horizontal and vertical lines for this map would be sufficient for a basis on which to place more details. On the other hand, in many of the river counties a map with a ten foot contour interval would be quite eleaborate. The speaker has a map of Danville drawn to a scale of one mile to the inch with a ten foot contour interval, which proves quite satisfactory.

The speaker consulted with the people at Washington and they thought that they could produce a map with a contour interval of ten feet, having a horizontal scale of one mile to the inch. The maps now made give all the information possible on that scale. They are published in an atlas. Each sheet covers fifteen minutes of latitude and fifteen minutes of longitude.

This matter of a topographic map should be taken up at once. It should be brought before the Legislature, and if possible some reasonable appropriation obtained and provision made for the completion of the map. The states of Michigan and Missouri are agitating this question; and if one or two succeed in the matter, the Illinois work would be abandoned for a number of years.

MR. J. H. BURNHAM: It apears to the speaker that the work outlined by the United States Geological Survey ought to be worth all that it costs. He is well acquainted with the state of Illinois and can say that there are a great many places in southern and central Illinois where a ten foot contour interval would do. In Bloomington, for instance, there is a difference in elevation of about ninety feet which would give a sufficient number of contour lines. The speaker does not believe that there are in McLean County many square miles in which a difference of elevation of thirty or forty feet could not be found, yet there are many places in the state, like Douglas and Champaign counties where there are large tracts of swamp lands.

This survey would certainly be very valuable and this Society does not run any risk in recommending to the state to co-operate with the general government.

MR. W. A. HAY: The speaker was connected with the survey of the state for the Worlds Fair and is acquainted with the details. It was the first intention in the survey to take out a barometer whenever it was stationary and carry it across country from one railroad station to another, noting the ground elevations. It was soon found that the results obtained were far from accurate. If the barometer had varied between stations it was not possible to find which of the readings were affected. It was finally decided to use two barometers, one to be used for making corrections to the readings of the other. Results by this method were far more accurate.

About $15,000 were expended and a map was produced which was as good as could be expected under the circumstances. It has a contour interval of ten feet all over the state and a county like Champaign has not many contours.

PROF. A. N. TALBOT: The speaker remembers at one time taking a barometer some twenty miles across country. He drove down stream where the fall was about five or six feet per mile and when he got to the place he started for, the barometer showed that he was about 250 feet higher than at the starting point. However there must be cases where errors of this sort could not be made.

The speaker first thought that ten foot contour intervals were quite large, believing that in the flatter portions of the state five foot intervals would be ebtter; yet there is a fall of forty or fifty feet in the city of Champaign alone, thus giving a number of countour intervals of ten feet.

The map would be invaluable in determining the line of the watershed between two different streams, in mapping of drainage areas, in determining the amount of discharge for sewerage of cities, and in some parts of the state to find where a water supply may be had. The society should encourage the state to take part in this expenditure, it would be a wise expenditure of money.

MR. H. G. PADDOCK: Along the Mississippi River use is made of government maps. The Mississippi River Commission maps and those of the Geological Survey have different scales, yet they work very well together. The Mississippi River Commission has made maps with contour intervals of from one to ten feet. Soundings are given for the whole river, some of which the speaker has checked and found correct to within two or three-tenths.

The speaker has used these maps to determine watersheds and the amount of fall on certain areas and found them very accurate.

DISCUSSION.

IN ADOPTING OLD CORNERS NOT MADE BY THE GOVERNMENT SURVEYORS, WHAT IS THE MAXIMUM ALLOWANCE TO MAKE FOR ERRORS IN ALINEMENT AND REARING?

MR. J. L. CLARK: The speaker is responsible for the question. In making resurveys a great discreptancy in distance and bearing is often found. This is more particularly the case with quarter section corners which have been placed by private surveyors. The question arose in the speaker's mind whether any limit of error could be set; so that if the error in the location of a corner exceeded this, a new corner could be placed at the proper point.

MR. W. A. HAY: To try to correct an old survey would produce endless litigation. For example;—in the city of De Kalb the lengths of blocks are much in error, some are too long others too short. If a surveyor should attempt to change the present lines in the lots so that the excess or deficiency were divided pro rata, the property owners would immediately protest, and in case of suit they would be upheld in court.

PROF. M. S. KETCHUM: The speaker is of the opinion that corners put in by private surveyors often attain the dignity of government corners and their location cannot then be changed by any subsequent survey. In making a resurvey of a private or government survey it is the function of the surveyor to find where the monuments, corners, lines and boundaries originally were and not where they ought to have been. Failing in this it is his business to re-establish them as nearly as posible in their original positions. No re-established monument, no matter how carefully located will have the same weight as the original earner if it can be found.

Corners put in by the government surveyors, corners put in by surveyors in accordance with the "Manual of Instructions to Surveyors" in completing the original surveys, and corners put in by surveyors in laying out townsites, subdivisions, or for a similar purpose, are original corners according to the law and must be accepted as the true corners if their locations can be definitely determined.

In case of conflict between two surveys the later will ordinarily yield to the earlier survey. In making a survey the surveyor has no power to decide disputed points. He should adopt those corners which will interfere least with ancient lines of ownership and which are most likely to be adopted by the courts. The intent of the grantor should prevail if possible, and an old well established fence line is better evidence of the intent of the parties than any survey made after all evidences of the intent of the parties than any survey made after all evidences of the original corners have disappeared. It is the duty of the surveyor in making a resurvey to maintain existing boundaries as nearly as possible and to endeavor to quiet title rather than disturb it. He cannot follow inflexible rules but must be governed by his judgment and by the court decisions and the peculiar phases of the particular point in question.

MR. H G. PADDOCK: There are two distinct classes of land corners: first, those made in original government surveys, which are the oldest; second, those made in subdividision authorized by law. The latter have the same value as the first. It is the duty of the surveyor in making a resurvey to locate these corners.

The Supreme Court of Illinois is more and more inclined to accept ancient land marks as indicating the original location of corners. A fence, for example, is evidence that two owners agreed upon a boundary. The surveyor should endeavor to locate points and markings which would tend to confirm each man's possession.

RESULTS OF LICENSE LAW FOR ARCHITECTS IN ILLINOIS.

BY N. C. RICKER.

In continental Europe, the profession of architecture can only be entered after a full course of technical studies in a school of architecture, a term of practical experience, and by passing a severe examination by state authority. This ensures the possession of an amount of professional knowledge and experience at least equalling the requirements for admission to the professions of law and medicine. It results, that the duties, powers, and renumeration of an architect are more clearly defined, and his responsibility for his work is greater, than is the case in the United States, where the profession is practically open to any person possessing the moderate capital necessary to equip an office, and who can secure some confiding clients.

This condition of affairs was long since considered objectionable by thoughtful architects, who agreed that at least a minimum professional knowledge should be possessed by every architect, and that like law and medicine, this profession should be protected from ignorant and dishonest pretenders, dangerous to life and health and promoting large expenditures of money, producing neither good architecture nor any adequate financial return.

The average citizen is frequently unable to distinguish between scientific physicians and quacks; he is still less likely to appreciate the great difference between a competent architect and one ignorant of sanitation, of the principles of construction, relying entirely on Divine Providence to sustain his buildings until after the collection of his commission.

The most feasible and effective method of regulating the architectural profession is the enactment of a license law, requiring some examination of the professional qualifications of architects and exercising some control over practice, with the punishment of dishonest acts. Such a law is quite similar to the laws regulating the practice of law, medicine, and pharmacy, now existing in nearly all civilized communities. It can only be based on the police powers of a state to protect the lives, health and property of its citizens, because a law authorizing inquiry into matters of taste and style would probably be adjudged to be unconstitutional. Americans have an inalienable right to spend their money in erecting buildings that are masterpieces of ugliness, so long as these do not endanger the health and lives of their occupants or of their neighbors, and this right cannot be abridged any more than their right to employ physicians of any "pathy" or lawyers belonging to any party.

New York was probably the first state to pass such a license law for architects, but this act was summarily vetoed by Governor Flower, who regarded it as merely a means for organizing a professional trade union, thus being purely class legislation.

Similar laws have been proposed in other states, especially in Ohio, Missouri, and Texas, but no such law has been enacted except in Illinois.

As early as 1895, at least, a license law was drafted by a committee of the Chapter of the American Institute of Architects in Chicago, being chiefly the work of the late Dankmar Adler of Chicago, who devoted much very valuable time and thought to this subject. The same committee appears to have endeavored to induce the legislature to favorably consider and pass this law, but it never passed the initial stage.

Some changes were made and a bill embodying it was introduced in 1897 by Hon. C. W. Nothnagel, an architect practicing in Chicago, then a member of the legislature, seconded by a committee of Chicago architects. To the general surprise of the profession, these efforts were successful, the law was enacted and approved by the Governor. A few amendments to remedy defects were further made in 1899.

The chief points of the present law are as follows:—

Each practicing architect must procure a license, obtain a personal seal bearing his name and address, and impress this on all working drawings and specifications issued from his office. This locates the personal responsibility for defective construction and for injuries to life or health. This license may be revoked for nonpayment of annual fee and restored on payment thereof. Or it may be revoked for incompetency, recklessness or dishonest practices after due trial before the Board. Penalty of from $50 to $500 per week is provided for practicing architecture without a license, and the Board is required to prosecute all violations and is authorized to expend funds for this purpose. These penalties are not received by the Board, but are paid into the local school fund.

In order to avoid any strong opposition to the enactment of this law, it was necessary to make two concessions, whose effect is temporarily injurious, but this condition is rapidly improving.

1. License without examination.

Any person practicing architecture as a profession on July 1, 1897, the time at which the law went into effect, was entitled to a license without examination of his qaulifications, provided he made application before January 1, 1898, and furnished satisfactory proofs of the fact. Although a careful investigation of the evidence was made in each case, the competency of the applicant could not be considered, and it is probable that a considerable number of incompetent men were necessarily licensed, to the disgust of some fully qaulified practitioners.

But it is certain that without this provision, strenuous opposition to the law would have been made by prominent architects, who regarded any examination into their competency as humiliating and as a possible means of injury that might be utilized by professional rivals. But a single architect, entitled to license on account of practice, has ever voluntarily taken the examinations prescribed by the law.

However, this mode of obtaining license became impossible after January 1, 1898, and the holders of this class of licenses are being rapidly replaced by those licensed after careful examination of their professional qualifications and experience, as provided in the law. Nearly one-sixth of the entire number have been thus replaced by younger and competent men within the past three years, so that at the end of fifteen years from this time very few will be left, and the architects in Illinois will form a professional body unequalled in professional equipment in any other state.

2. Contractors may make their working plans without obtaining license or using a seal. It is common for large contractors to furnish their own plans and specifications, accompanying these with a bid for the work, just like builders of steel bridges. When such plans are offered for bids from others and the work is let to another contractor, the author of the plans becomes an architect practicing without license and is liable to the penalties of the law.

This provision was inserted to avoid opposition of large contractors, but its operation is practically prevented in Chicago, where an ordinance authorizes the issue of building permits only for plans stamped with the seal of a licensed architect. This ordinance has practically compelled railways, builders of steel structures, and manufacturing companies erecting their own buildings, to place their work in charge of an employee possessing a license.

This provision of the law should be cancelled, since no reason exists why any distinction should be made in the responsibility for buildings, whether the designer and superintendent be a professional architect or an experienced contractor.

The law defines an architect as being professionally engaged in preparing plans and specifications for buildings, which are further defined as structures possessing foundations, walls, and roof, which includes some classes of engineering structures, and therefore engineers engaged in designing such structures are required to obtain licenses. This is simply just, because it would be improper to permit an engineer to practice architecture without a license, just as he would not be permitted to plead in a court of law without having been admitted to the bar.

The statement has sometimes been made that the law practically prevents non-resident architects from practicing in Illinois. But this is entirely untrue, for such architects may obtain licenses on exactly the same terms as those resident within the state. A considerable number of such licenses have been issued to architects residing in Boston, Cincinnati, St. Louis, and in various cities in Indiana.

In acordance with the provisions of the act, the Governor appointed a Board of Examiners to execute the license law, consisting of Hon. Dankmar Adler, President of the Board for the first two years, Peter B. Wight, its Secretary, W. H. Reeves, W. C. Zimmerman, and N. C. Ricker.

This Board first met and organized on September 3, 1897, and since no forms nor precedents for conducting its business existed, it first became necessary to prepare a series of blank forms and to arrange a system for handling the work, that should ensure justice to all applicants and speedy decisions in all cases. A blank application was sent to all applicants to be properly filled out and accompanied by an affidavit.

As a check on the statements made in the application, the names of two buildings were required, for which the applicant had been meployed as architect, together with the names and addresses of their owners. Letters to these owners soon elicited the facts, whether the applicant had actually been the architect of the building or merely a contractor for its construction. If satisfactory replies were received and personal knowledge, or inquiries made by the Board corroborated this information, the license was issued. It was manifestly impossible for any member of the Board to have personal knowledge of the eight hundred applicants for license on account of practice; but if it appeared that the applicant was merely a contractor, superintendent, or mechanic employed on the building, or if by a singular mental error, he had named a building with which he had no connection whatever, the case was laid aside and the applicant was requested to furnish more evidence.

As the time limit for filing applications at January 1, 1898, approached, the Board was almost swamped with applications, so that weekly meetings were held for several months, disposing of all cases on file soon after that date, excepting those of very doubtful character.

Many amusing experiences occurred, especially when requests to forward "them licenses" were received with promise of payment by return mail. One "electro" architect applied, who showed that he had designed some cottages costing as much as several hundred dollars a piece, and apparently taking his title from the electrotypes used for embellishing his advertising circular.

It was quite common for a doubtful candidate to obtain remarkable certificates of professional competency from his townsmen, believing that such papers would paralyze the Board. It was often interesting to learn that in the opinion of his friends, Mr. Blank of Podunk was the professional equal of any Chicago architect, thus giving to fame the name of a practitioner hitherto unknown to the profession. It was generally found that these certificates formed the chief qualification of the applicant, although the citizens sometimes expressed themselves entirely satisfied with his work and saw no reason why the state should interfere.

The dire vengeance of local political bosses and of legislators was occasionally threatened, if a license were refused, but this vengeance always failed to materialize, possibly because architects seldom have much time to devote to practical politics and to acquire such influence.

About 800 applications for license on acount of practice were filed, and of these about 700 were granted, after a very careful and patient consideration of each case, with a disposition to interpret and adminster the law as leniently as possible. More than 500 of these were issued to architects practicing in Chicago or its suburbs, which indeed seemed to be a large number for a city, where building had been almost prevented since 1892 by hard times and by disputes between contractors and trade unions. About 150 architects were licensed in the remainder of the state, and a score of more nonresidents obtained license. The number of applicants was indeed surprising, since no member of the Board would have expected to find more than 400 architects practicing within the state.

Besides the great number of architects in Chicago, other evidence demonstrated its vastness and its un-Americanized foreign population; for a Bohemian architect was found there, practicing entirely among his compatriots, who actually used specifications printed and written in the Bohemian language. It was necessary to employ an interpreter at his appearance before the Board.

After January 1, a new form of application blank was used, together with a different form of license, stating that its possessor had passed a satisfactory examination of his professional qualifications as prescribed by the law. This application for examination and license specifies the education and professional training of the candidate, the nature of his employment for the five years previous, and names any buildings designed by him. Working drawings and specifications of these buildings may be sent in, and resident architects are required to personally appear before the Board for oral examination. If this evidence and the qualifications of the applicant appear inferior to those required in the class examination, he is directed to appear at the next class examination, which is entirely written, continues for two and a half or three days and is conducted by a committee of three members of the Board, which marks the papers, identified by numbers only.

Two or three class examinations have been held annually, alternately in Chicago and at the University of Illinois. These relate only to the five points specified in the license law:—

"The examination shall have special reference to the construction of buildings, and a test of the knowledge of the candidate of the strength of materials, and of his or her ability to make practical application of such knowledge in the ordinary professional work of an architect, and the duties of a supervisor of mechanical work on buildings, and should also seek to determine his or her knowledge of the laws of sanitation as applied to buildings."

As before stated, no inquiry on any other subjects is authorized. Those specified are within the police powers of the state, upon which the law is based.

These examinations have been carefully arranged so as to place on equal footing the graduate from a school of architecture, the man trained in the office of an architect, or the competent mechanic or superintendent, educated by experience and private study. Possession of the required knowledge is essential, no matter where obtained. All kinds of candidates have been examined, from the simple mechanic or draftsman to the graduate of the best French school with a diploma entitling him to practice architecture in France.

Up to this time, 186 applications for examination and license have been received, and 120 of these candidates, or nearly two-thirds, have successfully passed the examinations and licenses have been issued. This makes a total of about 820 licenses issued, about 670 of these being now in force, showing a loss of about 150 architects.

This loss is caused by deaths, by removal from the state, by abandoning the profession, etc., but chiefly by revocation of licenses for failure to pay the annual renewal fee. It has doubtless chiefly occurred among architects licensed on account of practice, affording a basis for the previous statement, that about one-sixth of this class has been replaced by men that have passed the examinations.

One license has been revoked for dishonest practices.

The license law is enforced by the attorney of the Board, Hon. Charles N. Goodnow, of Chicago, who keeps a close watch on buildings and architects, and conducts all prosecutions in the courts for violation of the law.

The system of administration is largely due to the wise foresight and the careful thought of the late Dankmar Adler, a gentleman imbued with the noblest civic spirit; the very complete forms required were chiefly devised by Peter B. Wight, the Secretary of the Board; other members have devoted especial care to the examinations and the general work of the Board.

The general results of the law have been decidedly advantageous to the public, as well as to the profession.

Numerous shysters and incompetents have been driven out of practice, especially in Chicago and its vicinity, where a considerable number of men have been prosecuted and fined. There is plenty of room for this class outside of Illinois.

The professional status of the architect has been very materially elevated, and the general public is learning that there is a great difference between the architect and the contractor, and to beware of a person attempting to perform both services at the same time. No man should have an interest in the profits of the erection of a building built under his direction and subject to his approval, acting as the expert advisor and agent of the owner.

Draftsmen in the larger offices have been restrained from practising on their own account, unless they pass examinations and obtain a license, when they usually commence for themselves. This kind of practice had been quite common in Chicago, to the detriment of regular practitioners, who have to pay rent and other expenses, from which the draftsman is free. It was usually forbidden in the best offices. Cases have even occurred where draftsmen have been employed to work on competition drawings, and have made and presented other designs made by themselves on their own account, certainly a matter of bad faith.

The professional education and training necessary to the successful practice of architecture has very materially increased during the existence of the law. Nearly one-sixth of the number of architects licensed without examination have been replaced by men who have passed the examinations now required. Since this change has occurred within three and one-half years, it may reasonably be expected that all incompetent men will have left the profession at the end of the next ten years, when all practising architects will have either passed the examinations or possess equal preparation for their work. The professional standing of the architect should then in Illinois equal that of the lawyer or the physician.

Two very important changes are very clearly apparent at this time, and they are certainly in part due to the license law.

The country practice, excepting court houses and large school buildings, that are still designed by specialists, is rapidly passing into the hands of local architects, instead of Chicago architects. This gives the country architects plenty of work and produces a congestion of practitioners in Chicago, where architects do not yet appreciate this great change.

With the exception of great office and mercantile buldings, still monopolized by a few Chicago firms, the work of the profession is rapidly passing into the hands of younger men, whose education, training, opportunities for travel, etc., are far superior to those of their predecessors. It may be confidently expected that if a truly American style of architecture ever appears, it will be the work of these enthusiastic and energetic young men, and it is more likely to first appear in Chicago, the place of origin of those three great advances in modern architecture: the steel foundation and skeleton, the office building, and the rational mercantile buildng, now just developing into its permanent form.

DISCUSSION.

PROF. N. C. RICKER.—Objections are being made to the use of a seal for stamping drawings not made by the architect. One case came up before the Board when drawings had been made by an architect's employee; the architect stamped them when they were sent to his office. The Board decided that the architect had acted within his powers. Another case came up where an architect had been employed to place his seal on plans made by architects residing outside the State. The probabilities are that he took his seal out of the State to stamp the drawings. The license was revoked.

MR. F. OSWALD: It occurred in the speaker's practice that a man came to him with a proposition for the use of the speaker's seal. It was refused; but it seems that the man obtained the use of a seal from another architect whose license was later revoked. This is probably the case to which Prof. Ricker refers.

The speaker believes that it would be well to adopt a scale of charges. A scale is recommended by the Board in Chicago, but it would be well to appoint a committee to draft a scale which could be adopted by architects over the State.

REPORT OF COMMITTEE ON ARCHITECTURE.

The pratice of architecture in the State of Illinois has always held a distinct and honorable place since the State became one of the great states of the West in population and wealth. It was not, however, given definite metes and bounds until the passage, a few years ago, of the law for licensing of state architects by a State Board of Examiners. In the act referred to, architecture or the functions of a practising architect are defined. The good results following the enactment of the License law, in the nature of the case are slow in becoming apparent; but to the close observer the results have advanced to a point where they may be easily noticed. We venture to hope that under the wise management of the Board of Examiners all that was hoped for may be realized. Let us remember that the only strong argument for the passage of this law, and of any law requiring the public permit for any class or profession of men to do business in this State, is that the people of the State are protected and benefited by the enforcement of the law. The members of the professions sometimes feel that such laws were enacted for their preferment or advantage, and we sometimes meet architects who impatiently declare that they are not benefited or ask "What benefit is the State law to me which requires that architects be licensed in order to do business in this State?" The declaration and the question both indicate that such practitioners have not yet fully realized the true object of the law which is that it is not specially for the benefit of the architects but specially for the benefit of the public and only incidentally for the benefit of the architects. The laws requiring the licensing of physicians, druggists and attorneys are not specifically for the benefit of the several members of those professions, however much good they may obtain from and through them, but only for the protection and benefit of the people. Class legislation is unconstitutional, and no law will stand in litigation which was enacted for the benefit of a class or profession of individuals; but laws which are for general application and the benefit of the public are sound in the estimation of the courts. These remarks apply directly to the licensing of surveyors and engineers; and if a law to this effect is ever made it will be upon the sound basis on which safe legislation rests, the protection and help of the people.

The legislature of 1899 enacted a law providing for the appointment of a State Architect. His duties are to have charge of the construction of all buildings erected by the State. There are about twenty-five State boards in existence in this State in charge of the different charitable, penal and educational institutions; and every legislature, in the necessities of the case, appropriates a large amount of money for enlargement to provide for the growth of these institutions. That part of this money which goes into permanent improvements is to be expended under the direction and supervision of the State architect. The law, as it now is, has many faults, and it is a serious question whether it is possible to make its working successful at all. It is clear that the law will be radically amended at the present session, if not altogether repealed. It may be remarked that it is said that the law was enacted at the request, not of the people of the State, but for the express advantage of a few men who thought they could control the appointment. It is to be hoped that no such motive will prevail in its amendment, or there will be danger of its entire repeal.

S. A. BULLARD,
N. C. RICKER,
J. G. MELLUISH,
Committee.

DISCUSSION.

MR. S. A. BULLARD.—The speaker wishes to mention some of the difficulties which the State Architects have met. The twenty-five Boards are entirely independent, working under dfferent heads. One architect can not easily work in harmony with all these Boards. The Legislature will probably do something to bring these offices together. Gov. Tanner recommended that all charitable institutions be placed under one head. If a consolidation of this kind is made it will be possible for a state architect to work with some effect.

INVENTION IN THE NINETEENTH CENTURY.

BY JACOB A. HARMAN.

The last 25 years have been the most prolific in invention of any period. In this country the patent office has granted half a million patents; while during the first 75 years of the century 150,000 patents were issued. Progress in invention has been by small and almost imperceptible steps. Even the great principles which have revolutionized the arts are the result of the work of many men continuing through years. So closely does invention follow industrial requirements that seldom is an article required which is not soon supplied.

The steam engine, which was well known and considerably used in the preceeding century, has been developed and extended in uses until to-day it is the life-blood of our industrial progress. The primitive form with throttling governor, as invented by Watt in the latter years of the last century has been improved until the Corliss valve-gear and automatic cut-off and triple and quadruple expansion have brought it very near to the apparent limit of economy. The steam engine has made possible our present high development of transportation on land and sea; and it surely deserves the greatest share of credit for our material progress. Without its wonderful adaptability to all conditions requiring use of power, many of the inventions of to-day would not have been required.

The dynamo with all its progress has required the services of the steam engine to supply it with the energy which it converts into electricity.

The greatest efforts in invention are now being directed toward cheapening production; and as the steam engine has been so nearly perfected that very little further economy in operation is attainable, a more recent invention, the internal combustion engine, the common type of which is the gas and gasoline engine, is becoming a very active competitor and bids fair to outstrip this pioneer of progress. It may be interesting to note that the steam engine of to-day, as found in general use in plants of approximately 100 horsepower, is delivering, in power, the equivalent of only one to two per cent. of the energy of the fuel consumed; and in the highest type of steam engines seven or eight per cent. fuel efficiency is attained, the remainder, so far as development of power is concerned, is lost. The gas engine, on the contrary, shows a fuel economy of 25 to 30%

When Prof. Morse, in 1844, succeeded in sending a telegraphic message from Baltimore to Washington over the line constructed by the United States government, one of the great triumphs of the century was attained; and when in 1858 the first trans-Atlantic cable was put in successful operation, the triumph was apparently complete. Scientists had perceived about the middle of the 18th century that it was possible to communicate at a distance by means of electricity, but almost 100 years passed before it was accomplished. The first Morse receiver was a recording device, but it was only a few years until the operators received by sound. Many improvements followed, leading to the invention of the telephone by which the human voice is instantly reproduced in all of its modulations; so that now to converse with a friend 1,000 miles or more away is a common occurrance, and for our local affairs the "phone" is really a necessity. Then comes the phonograph and graphophone which record, and when demand is made, reproduce to the minutest detail all classes of sounds. These instruments are extensively used for amusement, and with them are provided endless varieties of music and comic dialogue.

In 1831 and 32 when the early telegraph instruments were nearing perfection, the first steps were being taken towards what is now the marvel of the age and one of our most useful inventions, the dynamo, but until about 1865 the voltaic battery which generates electricity by chemical decomposition was the only practical means of producing electricity for commercial purposes. The telegraph and electric light and many other useful discoveries were rendered possible by batteries, but the cost and limited current restricted practical application to the telegraph and laboratory. Active development of the dynamo began in the early seventies, and so great has been the progress that its use has become well nigh universal. Electricity has revolutionized transmission of light and power. It furnishes power over miles of slender copper wire to drive a fan for cooling in summer, a pump for supplying water, light our streets and houses, or to operate a factory. It propells our street cars and is now an active competitor with the steam railroad for local traffic. It is used extensively in the arts for welding, and the electric furnace has made possible the production, on a commercial scale, of carborundum and calcium carbide. This being but a beginning, so little being really known of electricity as yet, great hopes are entertained for its further development.

In all the preceding centuries hand sewing was exclusively employed, and it was reserved to the nineteenth century to relieve women from the drudgery which for so many centuries enslaved them. Embroidery machines had been patented in England as early as 1755. In 1826 Lye was granted a United States patent on a sewing machine, but no records remain as all were burned in the fire of 1836. In 1830 a sewing machine was invented in France. Eighty, made of wood were used for sewing army clothes; but they were destroyed by a mob, as many other labor saving inventions had been before. The development of the modern sewing machine, however, began with the work of Elias Howe, who obtained his first patent Sept. 10, 1846. Meeting with little encouragement, Howe went to England to introduce his machine, but failing, returned to find that sewing machines embodying his invention were being sold. He won his suit against the infringers who were obliged to pay royalties which were estimated in 1863, at $4,000 per day. Improvements without number have been invented, and a great variety of standard machines for ordinary use are now on the market, besides those for numerous special applications. One concern alone is said to manufacture over 400 different varieties of sewing machines.

While the housewife was being supplied with a sewing machine, as well as many other inventions of minor importance, the field-hand has not been neglected. The rude plows of early time have been replaced by the modern riding plows, cultivators, and disc harrows drawn by horses, and gang plow drawn by the traction engine; the sickle and cradle by the mower and reaper, and later the self-binding harvester performing the work of twenty men, cutting and binding the grain and arranging the bundles in wind-rows. The flail has given place to the modern steam thresher, and finally the harvester propelled across the field by steam which by the same power cuts a swath 28 ft. wide, threshes the grain, and puts it in bags as it movet along, requiring two expert hands to sew up the bags and dump them on the ground. The task of this machine is 75 acres cut and threshed in a day.

Automatic machinery has reached a very high stage of development in manufacturing. In weaving, the hand loom has been superseded by the power loom in which the shuttle flies at the rate of 180 to 250 strokes per minute, yet the complex organization of the machine works with an energy, a uniformity, an accuracy, and a continuity that leaves far behind the strength of the arm, the memory of the mind, and the accuracy of the human eye, and yet if the tiny thread breaks, the whole organization instantly stops and patiently waits the remedial care of its watchful master.

Machines for automatically making nails, pins, tacks, screws, and a multitude of useful articles have reduced the cost to a mere trifle. In the item of pins alone, it is said that 20,000,000 a day are required to supply the demand in the United States. Among the labor saving inventions we must not forget the typewriter which has reduced our daily business correspondence to the accuracy and legibility of print, writing at a speed which is truly marvelous. The typewriter is also the product of the last 25 years of the century and in that time it has reached a perfection beyond which little is apparently required. The present yearly output of typewriters in the United States is estimated between 75,000 and 100,000. The cash register, which by pressing the proper keys, adds the amounts of cash deposited, making a record of each sum placed in the drawer, and the mechanical computer which, by the manipulation of keys and levers, will add, substract, multiply, or divide are likewise late inventions of great utility, performing with accuracy the work of many persons.

Refrigeration, and artificial ice making has come to be one of our established industries. The first patents were taken early in the century, but no practical general application was made until the last quarter of the century. Refrigeration is accomplished by evaporation of ammonia or other volatile gas which absorbs the the heat of surounding bodies rendering them cold. Refrigerator cars and compartments in ships are used for transportation of fresh meats and fruits from coast to coast; and without the means of artifically producing cold as well as heat we would not have our present industrial development.

The certainty with which the great bridges, tunnels, and steel skelton buildings are designed and executed by the engineer places this class of structures truly with the inventions of the past century. Water works, gas works, asphalt and brick pavements, modern sewerage and sanitation, heating and ventilation, are all comparatively recent and integral parts of our progress.

Alfred Russel Wallace in reviewing the progress in inventions and practical applications of science, which are perfectly new departures and which have so rapidly developed as to have profoundly affected many of our habits and even our thoughts, gives them as follows:

1. Railways, which have revolutionized land-travel and the distribution of commodities.

2. Steam-navigation, which has done the same thing for ocean travel, and has besides led to the entire reconstruction of the navies of the world.

3. Electric Telegraphs, which have produced an even greater revolution in the communication of thought.

4. The Telephone, which transmits, or rather reproduces, the voice of the speaker at a distance.

5. Friction Matches, which have revolutionized the modes of obtaining fire.

6. Gas-lighting, which enormously improved outdoor and other illumination.

7. Electric-lighting, another advance, now threatening to supersede gas.

8. Photography, an art which is to the external forms of nature what printing is to thought.

9. The Phonograph, which preserves and reproduces sounds as photography preserves and reproduces forms.

10. The Roentgen Rays, which render many opaque objects transparent, and open up a new world to photography.

11. Spectrum Analysis, which so greatly extends our knowledge of the universe that by its assistance we are able to ascertain the relative heat and chemical constitution of the stars, and ascertain the existence, and measure the rate of motion, of stellar bodies which are entirely invisible.

12. The use of Anaesthetics, rendering the most severe surgical operations painless.

13. The use of Antiseptics in surgical operations, which has still further extended the means of saving life.

There were handed down to the 19th century the following:

"In the eighteenth, we may perhaps admit the development of the steam engine from the rude but still useful machine of Newcomen, to the powerful and economical engines of Boulton and Watt. The principle, however, was known long before and had been practically applied in the previous century, and the improvements made by Watt, though very important, had a very limited result. The engines made were almost wholly used in pumping water out of deep mines."

In the 17th century the one great and far reaching invention, was the telescope. The barometer and thermometer were minor inventions.

In the 16th century we have no invention of the first rank, but in the 15th, we have printing.

The mariners' compass was invented early in the 14th century and thus facilitated the discovery of America. Then backward to the dawn of history or rather prehistoric times, we have the two great engines of knowledge and discovery, the Indian or Arabic numerals, leading to Arithmetic and Algebra and more remote still the invention of Alphabetical writing. Summing these up, we find only the steam engine, the barometer, the telescope, the printing press, the mariners' compass, Arabic numerals, and alphabetical writing, seven in all, as against thirteen in our single century.

THE EFFECT OF CURVATURE ON THE STRENGTH OF MACHINE PARTS.

BY G. A. GOODENOUGH.

The general theory of the stresses in bars with curved centerlines may be found in the German works of Bach and Grashof. Strangely enough this important part of the subject of strength of materials has not received any consideration by American writers, probably because our American and English text books are written primarily for civil engineers who are concerned with straight beams, struts, etc. In this short article the author does not propose to develop the theory; for this the reader is referred to the works above quoted. The author wishes merely to call attention to the fact that there is such a theory, and to show by a familiar example the serious error of computing stresses in curved bars by laws that hold true for straight bars only.

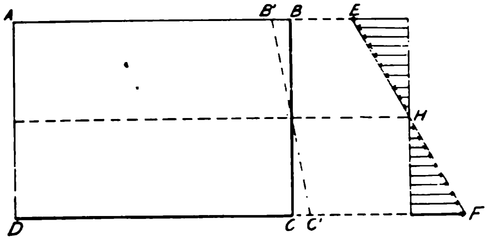


FIG. 1.

In Fig. 1, A B C D represent a part of a straight bar, A D and B C being parallel cross sections. If the bar is subjected to the action of a couple it will bend, and the sections will change their relative position; assuming AD to remain in its original position, BC will take the new position B'C'. The usual assumption of the theory of flexure are: (1) the plane section BC remains a plane section in its new position; (2) the stress in any fiber is proportional to the specific elongaton of that fiber. Now since the elongation in any fiber is proportional to the distance of the fiber from the neutral surface, and since the fibers are originally of the same length, it follows that the stress in fiber is proportional to the distance of the fiber from the neutral surface. The stress is therefore a linear function and the graphical representation of the stress will be that given by the straight line EHF.

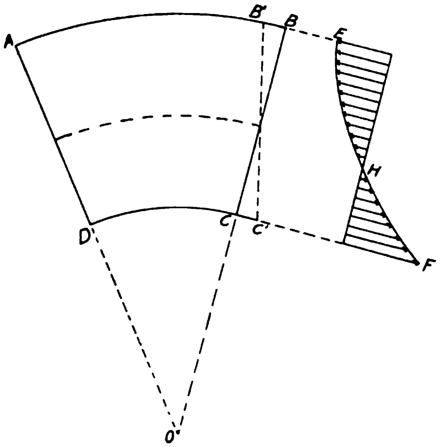


FIG. 2.

Suppose however the bar or beam is curved, as shown in Fig. 2, the center of the curvature being at O. A couple acts on the part under consideration and the Section BC assumes a new position B'C' due to the bending moment of the couple. Assuming that the section in its new position remains plane, the elongation of a fiber is as in Fig. 1, a linear function of the distance of the fiber from the neutral surface. However, the original lengths of the fibers are different at different points of the cross section, those on the concave side being the shorter; hence, though the absolute elongation of any fiber is proportional to the distance of the fiber from the neutral surface, the specific elongation and in consequence the stress is *not* thus proportional is *not* a linear function of the distance from the neutral surface. Evidently, the maximum specific elongation and maximum stress occurs at the inner concave surface CD. The distribution of stress over the cross section will be that shown by the curve EHF, Fig. 2.

Let a curved bar be loaded in such a manner that a section is subjected to the action of a normal load P producing direct tension or compression and a couple with a bending moment of magnitude M. The customary method of computing the maximum stress in the section is to find the stress due to the bending moment precisely as in a straight beam and add to this the direct stress produced by the load P. Denoting by S, the stress due to bending, by I the moment of inertia of the section about its neutral axis, and by C the distance of the strained fiber from the neutral axis, the ordinary theory of flexure gives for straight beams the formula:

$$S_2 = \frac{Mc}{I}$$

If A denotes area of the cross section, the direct stress is: $S_2 = \frac{P}{A}$; hence the maximum stress is: $S = S_1 + S_2 = \frac{P}{A} + \frac{Mc}{I}$

This method of computation is easy, and is correct for eccentrically loaded *straight* bars. When applied, however, to curved bars, it obviously leads to inexact results, since it makes the stress a linear function of the distance of the fiber from the neutral surface and neglects entirely the curvature of the bar. It will be found that by thus treating the curved bar as an eccentrically loaded straight bar, the stresses computed will be too great for the fiber on the convex side and too small for those on the concave side. The magnitude of the error will depend upon the curvature.

The exact formula for computing the stress at any point of a section of a curved bar is the following:

$$\left\{ S = \frac{P}{A} + \frac{M}{AR}\left(1 + \frac{I}{Z} \times \frac{E}{E + R}\right) \right\}$$

S = intensity of stress at any fiber.

P = normal force distributed over section;

M = bending moment of couple;

A = area of section;

R = radius of curvature of center line of bar at section in question;

E = distance of fiber from plane through gravity axis;

Z = a factor depending upon the form of the section and the radius of curvature.

The force P is to be taken positive when it produces tension; M is positive when it tends to increase the curvature of the bar; E is positive when measured from the axis towards the convex side, negative when measured towards the concave side.

The factor Z, depends upon the form of the cross section and upon the radius of curvature; it may be found by evaluating the integral.

$$\left\{ Z = \frac{-1}{A} \times \text{integral} \frac{E}{R + E}\, d\,A \right\}$$

Bach gives the following expression for Z for the section most in use:

1. Rectangle, width b and depth h = 2c.

$$\left\{ \begin{array}{c} Z = -1 + \frac{R}{h} \log_e \frac{2R + h}{2R - h} = \frac{1}{3}\left(\frac{C}{R}\right)^2 + \\ \frac{1}{5}\left(\frac{C}{R}\right)^4 + \frac{1}{7}\left(\frac{C}{R}\right)^6 + \ldots\ldots \end{array} \right\}$$

2. Circle of radius a,

$$\left\{ Z = \frac{1}{4}\left(\frac{a}{R}\right)^2 + \frac{1}{8}\left(\frac{a}{R}\right)^4 + \frac{5}{64}\left(\frac{a}{R}\right)^6 + \ldots\ldots \right\}$$

3. Trapezoid with the dimensions shown in Fig. 3,

$$\Big\{ Z = -1 + \frac{2R}{(b_1 + b_2)h} \Big\{ \Big[b_1 + \frac{b_1 + b_2}{h} (e_1 + R) \Big] \log_e \frac{R + e_1}{R - e_2} - (b_2 - b_1) \Big\}$$

To show the difference between the results given by the two formulas, the author has chosen a crane hook as a familiar example of a curved bar. From a table of proportions published recently in the American Machinist, the dangerous sections of a hook for a load of 10 tons has the following proportions, the form of the section being the trapezoid ABCD, Fig 3:

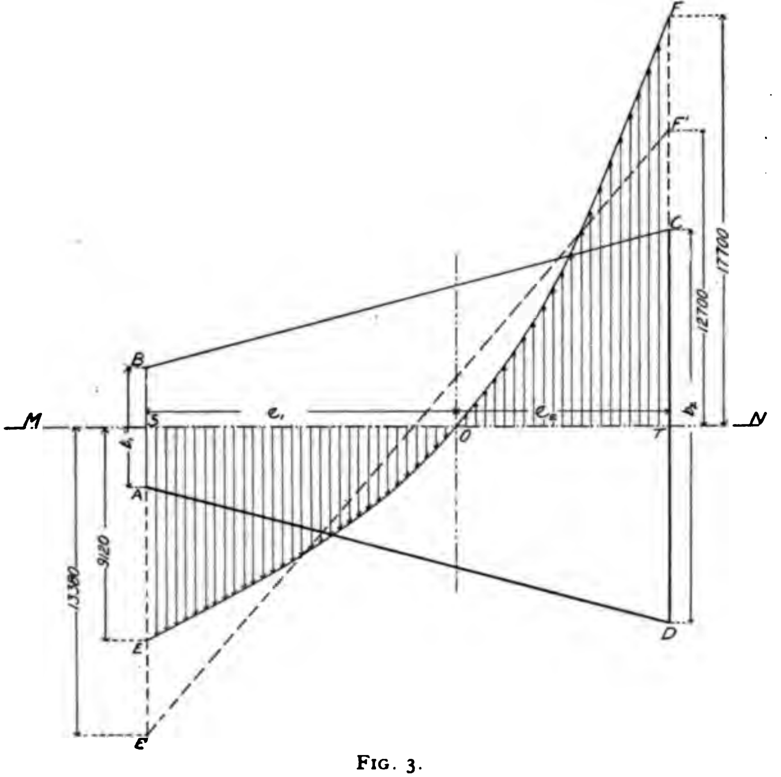


FIG. 3.

Short side $b_1 = 1$ inch;
long side $b_2 = 3\frac{3}{8}$ inches;
depth $h = 4\frac{1}{2}$ inches.

The distance c_2 of the center of gravity o from the long side is found to be 1.843 in., the area of the sections is 9 27-32 sq. in., and the moment of inertia about the gravity axis is 14.985, using the formula: $S = \frac{P}{A} + \frac{Mc_2}{I}$, the intensities of the stress at the inner fibers along CD and at the outer fibers at AB are given by

$$S = \frac{P}{A} + \frac{Mc_2}{I}$$

$$\left\{ \text{and } S = \frac{P}{A} - \frac{Me_1}{I} \right\}$$

respectively. The line of action of the force P is at a distance of 2½ inches from CD, giving for the lever arm of the couple 4.343 inches. Substitutive known quantities.

$$\left\{ \begin{array}{l} \text{Stress at CD} = \frac{20{,}000}{9\frac{27}{32}} + \frac{20{,}000 \times 4.343 \times 1.843}{14.985} = 12{,}700 \\ \text{Stress at AB} = \frac{20{,}000}{9\frac{27}{32}} - \frac{20{,}000 \times 4.343 \times 2.657}{14{,}985} = -\,13{,}380 \end{array} \right\}$$

Apparently the section is well proportioned, the tension at CD being slightly less than the compression at AB.

To use the more exact formula, the radius of curvature R of the center line of the hook at the section must be known. In this hook, the center of the rope lying in the hook was taken as the center to describe the outline of the hook; hence $R = 2.5 + 1.843 = 4.343$ approximately.

$$\left\{ \begin{array}{l} Z = -1 + \frac{2 \times 4.343}{(1 + 3\frac{3}{8})\ 4\frac{1}{2}} \left\{ \left[1 + \frac{3\frac{3}{8} - 1}{4\frac{1}{2}} \times 7\right] 109, \frac{7}{2\frac{1}{2}} - (3\frac{3}{8} - 1) \right. \\ = .0846 \end{array} \right\}$$

$$\frac{I}{Z} = 11.82$$

Since in this case, the line of action of P passes through the radius of curvature, $-\frac{M}{R} = P$, and the formula reduces to

$$\left\{ S = \frac{M}{ARZ} \times \frac{e}{e + R} = 11.82 \frac{M}{AR} \times \frac{e}{e + R} = -11.82 \frac{P}{A} \times \frac{e}{e + R} \right\}$$

For the fiber CD, $e = e_1 = -1.843$, and $e + R = 2.5$; hence

$$\left\{ S = \frac{11.82 \times 20{,}000 \times 1.843}{9\frac{27}{32} \times 2.5} = 17{,}700 \text{ nearly} \right\}$$

For the fiber AB, $e = e_2 = 2.657$, $e + R = 7$, and

$$\left\{ S = \frac{-\ 11.82 \times 20{,}000 \times 2.657}{9\frac{27}{32} \times 7} = -\ 9120 \right\}$$

At the gravity axis $e = 0$, and $S = 0$.

The stresses in the section are shown graphically by the curve EF, Fig. 3, while the stresses computed by the first method are shown by the straight line E′F′. At the inner surface CD, the stress computed by the approximate method is too small by

$$\left\{ \frac{17{,}700 - 12{,}700}{17{,}700} = 28\tfrac{1}{4}\ \% \right\}$$

This example is sufficient to show the large error introduced by the ordinary analysis when the piece has a rather small radius of curvature. This error of course grows smaller as the curvature is less and may be neglected when the radius of curvature becomes 8 or 10 times the depth of the section.

The theory that the curvature influences the strength of a bar is denied by some authorities, who assert that the cross sections do not remain plane as assumed, but become distorted in such a way as to reduce the stresses to those that would result in a straight beam with the same loading. In regard to this contention, it is of course now well known that the cross sections are distorted even in ordinary flexure of straight beams, and that in this respect the ordinary theory of flexure, resting as it does upon the assumption of the section remaining plane, is defective. It is conceded, however, that the results obtained by the use of the ordinary formulas for the flexure of straight beams are practically exact, nowithstanding the error in the assumptions. Bach has shown, furthermore, that the distortion of the sectum that actually occurs is quite different from the distortion that would be necessary if the stresses were to be reduced to those in straight bars. While it may be true that the computation taking curvature into account may give stresses slightly in excess of the true stresses, the error if any is on the safe side; on the other hand, the easy method of treating the curved bar as an eccentrically loaded straight bar, gives stresses that are probably much smaller than the true stresses, and the error is surely on the wrong side.

If it be accepted as true that curvature has an effect upon the strength of a bar, the following conclusions seem obvious:

1. In the design of machine parts, sharp curvature is to be avoided as far as possible, especially in the region of sections subjected to maximum bending moments.

2. When a part *is* curved, the maximum stresses should be computed by the exact formula unless the radius of curvature is large in comparison with the linear dimensions of the section.

REPORT OF THE COMMITTEE ON MECHANICAL ENGINEERING.

SOME ENGINEERING LAND MARKS.

BY E. E. JOHNSON, CHAIRMAN.

It is the purpose of this report to point briefly to the engineering landmarks of the century past, and to the development attained at the end of it.

Probably no invention has produced results so profound and far reaching as that of the steam engine. The first engines were for pumping service, and were single acting. Newcomen produced this machine in 1705, but James Watt was the first to apply the principles of expansion and of the separate condenser about 1765. Steam of 10 or 12 pounds pressure was available and as a consequence large cylinders were necessary. A Watt engine erected at Smethwick for the Birmingham Canal Navigations in 1777 was removed in 1893, having been in service 120 years. Its cylinder was 32 in. diameter by 8. ft. stroke, and its duty 18,000,000 foot pounds per bushel of coal of 84 lb., or a duty of 21,000,000 foot pounds per million B. T. U., approximately. High duty pumping engines of recent design give upwards of 145,000,000 duty on a B. T. U. Basis. The engine left the hands of Watt in practically its present form; aside from the principle of compounding, introduced by Hornblower 1775, has been changed in form and detail only. Sickles and Corliss in America introduced radical changes in the valve gear.

It is in its capacity as a power producer that the steam engine has made possible the enormous strides in all branches of the mechanics arts. The temples and monuments of the ancient civilizations which are still marvels of construction were, no doubt, erected by slave labor; for power from some source must be at the command of the engineer. The steam engine has for more than a hundred years been the willing slave of all industries, and men's hands are free to produce other things than power.

The century began with the steam engine well developed and needing only the pregnant thought of practical men to enlarge its field. In 1807 Robert Fulton made his memorable voyage in a steam propelled boat, the "Clermont," on the Hudson river. It was a triumph for the paddle wheel which has since then held its own on river navigation throughout the world. It remained for Captain John Ericson and others to bring the screw propeller into use in 1837. This solved the problem of deep water propulsion of vessels and paved the way for the design of the ocean going craft of today. In 1899 the ship yards of the world produced a tonnage of 2,569,000 tons. In the same year English yards alone built marine engines of 1,400,000 aggregate horse power.

But not alone in stationary positions and for navigation was there necessity for engines. Mine haulage and goods transportation set English minds to thinking and as early as 1820 Stephenson began to experiment, and by 1830 he had a short line of railroad in operation. In the United States the new idea early took root, and the immense territory to be opened up and connected have made it one of the foremost railroad producing countries of the world. By 1850 railroad transportation had reached Chicago from the East. At the end of the century we had 236,911 miles of railroad employing 35,810 engines. Stephenson's heavy engines weighed 7 tons. Engine weights of 150 tons are now being provided for in railway bridge designing.

It has been aptly said "No one improvement in mechanics can advance much beyond the general form of what may be termed the "industrial progress of the age" and we may rightly expect the impetus given by the advent of the steam engine to have carried other arts along with it. Such indeed was the case.

The invention of the power loom in England by Cartwright in 1787 followed by that of the cotton gin by Whitney in 1793 in the United States laid the foundation for the century's advance in the manufacture of textiles. The spinning capacity of United States mills in 1899 was 17,937,735 spindles.

In 1841 an ingenious Yankee,—Elias Howe, gave to the world the sewing machine, to make this domestic labor less irksome and bring into being the countless manufacturing industries which to-day depend upon it. Almost every article of clothing from hats to shoes pays tribute to Howe and his successors. A shoe, for example, which was whollv the product of hand skill at the beginning of the century, is now the result of some 70 successive individual processes in factory production resulting in immennse profit to the user.

Electricity. the most subtle of all the century's servants, has been the subject of more careful scientific research than any other branch of the arts which embraces mechanical detail in a considerable degree. In 1832 Samuel F. B. Morse transferred signals electrically over a wire using a battery circuit, and from the simple instruments with a speed of 40 words a minute have grown complex systems of transmission, till now a single wire can be made to carry 4000 words per minute. In 1838 Cyrus W. Field conceived the idea of uniting continents by telegraphic cables and after five years of constant efforts saw his efforts crowned with success. Forty-two years later the oceans of the world cover 150,000 miles of cable, and a message girdling the earth can be sent by anyone who will pay the toll. The United States alone has 1,000,000 miles of telegraph lines in service.

In 1876 Alexander Graham Bell and Elisha Gray simultaneosusly made the great stride of transmitting musical sound and articulate speech as Morse did telegraphic signals in 1832. In 25 years thereafter no town of any considerable size is without its system of telephones, and long distance telephone lines are becoming as extensive as telegraph lines. The impetus given to business interests by these twin electrical servants needs only be suggested.

The mechanical skill and foresight which have made possible the commercial expansion of the United States has involved a method which is now so common as to excite no comment, and which has contributed largely to our present commercial standing, namely, the interchangeable system of machine construction. As an example of advanced practice it may be stated that watch movements are now produced in whose construction hand skill plays almost no part until they are assembled; all finishing and machining of parts being done by automatic machinery, whose product after being inspected, may be used in any one of 100,000 similar movements.

The great power producing slave of the century has a new rival in the field which is already making its way in special lines. The internal combustion engine dates practically from 1870, and until recently was used for small powers only. Its introduction in large units of say 1,000 horse power is becoming practical, and in certain situations it is destined to replace steam as a prime mover. Its thermal efficiency or ratio of useful effect related to energy used per horse power is approximately double that of the steam engine; hence, its great economy in fuel.

The manufacture of iron was one of the first arts to feel the stimulous of the steam engine era, and has kept steadily up to the requirements of the commerce it engendered. It furnishes an index both of the state of commerce and the growth in the field of engineering. Watt in his time was hampered by the imperfections of the iron master's art, high pressure steam being impossible of production because no boiler plates would hold it; it remained for other hands than his to utilize steam to the limit of pressure and temperature possible with satisfactory lubrication. Iron has been produced in a crude way for many centuries. The first of the great improvements in its production was that of puddling by Cort in England in 1784. In 1830 Bulson introduced the hot blast for furnaces which reduced the coal consumption per ton by one-half. The next great step was the introduction of the Bessemer process of steel making which was first put into operation in the United States in 1856. Rails for railroad work were first rolled in the United States in 1840. In 1857 the "three high" mill for rolling was introduced.)

The growth in the production of iron in the United States is shown in the following table:

Date.	Gross Tons.
1810	53,908
1820	20,000
1830	165,000
1840	286,903
1850	563,755
1860	821,223
1870	1,665,179
1880	3,835,191
1890	9,202,703
1899	13,620,703

These striking figures illustrate both commercial progress of the nation and the breadth of the field occupied by engineering in connection with production and use of iron and steel. The mechanical engineer has been as often the product of the mill as of the school. Both theory and practice are necessary to the highest development of skill.

At no time has there been so much data worked out and available in all lines for the use of engineers and excellent school training in the fundamentals of engineering knowledge are now more easy of access than ever before. In fact the growth of such training schools is one of the marked features of the century.

With a century behind him filled with the commercial, social, and ethical progress in whose vast achievements he has been a factor the engineer faces the problems of the present with the courage born of success.

Jerome Plankinton

Jerome Plankinton member of the Illinois Society of Engineers and Surveyors died January 14th, 1901, at his home in Chicago, Illinois. He was actively engaged in land surveying in Chicago from 1869 until the time of his death, and had been a member of the Illinois Society of Engineers and Surveyors for the last ten years. He was careful, conscientious and thoroughly honest. It was a by-word among his associates that "Plankinton's word was as good as a bond."

Mr. Plankinton left no family, his wife having died three years before his death. By his death the engineering profession loses an able and conscientious worker and the Illinois Society of Engineers and Surveyors loses a loyal member.

ANNUAL REPORT OF THE EXECUTIVE SECRETARY AND TREASURER.

FOR THE YEAR ENDING JANUARY 25, 1901.

CHAMPAIGN, ILLINOIS.

To the Illinois Society of Engineers and Surveyors:

GENTLEMEN: I herewith submit my report as Executive Secretary and Treasurer for the year ending January 25, 1901:

RECEIPTS.

Balance on hand January 23, 1900	**$ 29.80**	
Received for initiation fees,	**121.00**	
" " annual dues,	**317.00**	
" " sale of reports,	**5.00**	
" " advertising,	**291.43**	
Total,		**$764.23**

DISBURSEMENTS.

Balance printing 14th Annual Report,	**$114.60**	
Paid on printing 15th Annual Report,	**275.60**	
Stenographer at 15th Annual Meeting,	**50.00**	
Postage and express,	**103.71**	
Miscellaneous expense,	**86.32**	
Salary Executive Secretary and Treasurer,	**100.00**	
Balance cash on hand,	**34.00**	
Total,		**$764.23**

The Society is out of debt for the first time in several years.

There are now one hundred and thirteen (113) members in good standing, as compared with eighty-one (81) a year ago, five (5) have resigned during the year after having paid their dues, and a number have been dropped from the list for non-payment of dues.

Many of the articles published in the 15th Annual Report have been printed in the technical journals; 1600 copies of the 15th Annual Report were printed.

Exchanges were made with the following list of Societies:

(1) Ohio Society of Engineers.
(2) Assoc. Engineering Societies, University of Illinois.
(3) Engineering Society of University of Michigan.
(4) Civil Engineering Society of Purdue University.
(5) Connecticut Civil Engineers and Surveyors.
(6) Iowa Society of Civil Engineers and Surveyors.
(7) Association of Ontario Land Surveyors.
(8) Michigan Society of Engineers.
(9) Indiana Society of Engineers.
(10) Engineering Association of the South.

Copies of the reports of these societies have been sent to all members in good standing.

Copies of the 15th Annual Report have been sent to the following libraries:

Library of State University of Iowa.
" " " Tennessee.
" " " Missouri.
" " " Illinois.
Chicago Public Library.
Library of Oberlin College.
" Rose Polytechnic Institute.
" Massaschusetts Institute of Technology.
" Washington University.
" Rensselaer Polytechnic Institute.
" University of Chicago.
" Armour Institute of Technology.
Illinois State Library.

Engineering Library of University of Illinois.
American Society of Civil Engineers.
Congressional Library.
Library of the Engineering Department of Michigan.
" " " " Cornell University.
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Western Society of Engineers.
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Civil Engineers' Club of Cleveland, Ohio.
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Engineers' Club of Philadelphia.
U. S. Geological Survey.

Respectfully submitted,
M. S. KETCHUM,
Secy. and Treas.

JANUARY 25, 1901.

SEVENTEENTH ANNUAL REPORT

OF THE

ILLINOIS SOCIETY

OF

ENGINEERS AND SURVEYORS

PROCEEDINGS OF THE SOCIETY

AT THE

SEVENTEENTH ANNUAL MEETING

HELD AT

JOLIET, ILLINOIS, JANUARY 22, 23, 24, 1902.

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Alvord, John W., Civil Engineer...............127 Hartford Building, Chicago
Anderson, C. G , Civil Engineer... ....24 Arcade Building, Peoria
Ashley, Burton J., Chief Engineer Zion City.......1201 Mich. Boul , Chicago
Atwood, L. P., Eng'r M. of W., R. G. S. M. & P. R'y..................
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Beasley, Harry E., Civil Engineer...............712 Niagara Building, Peoria
Bell, A. H., Civil Engineer and County Surveyor............... .Bloomington
Blanding, M. J...... ....North Brookfield, N. Y.
Bremer, H. H., Surveyor....................Room 616, 112 Clark St., Chicago
Brown, Geo. A., Civil Engineer...............................Bloomington
Brown, Geo. W., Civil Engineer.......................................Joliet
Bullard, Samuel A., Architect and Sanitary Engineer, 208 Sixth St., Springfield

Carberry, Ray S., Civil Eng'r, Engineer's Office, O. S. L. R. R., Pocatello, Idaho
Chandler, Geo. W., City Engineer........... ....Canton
Chase, Chas. P., City Eng'r and Manager Iowa Engineering Co....Clinton, Iowa
Chipman, Paul, Civil Engineer....... ....Mt. Carmel
Clark, G. M., Drainage Engineer, Woodford County................Low Point
Clark, J. L., Surveyor and Civil Engineer........... ....Momence
Connolly, Frank M., Assistant City Engineer................. .... Galesburg
Cornell, W. H., Draftsman Ft. Pitt Bridge Co........... ....Canonsburg, Pa.
Crowley, John, Supt. for Flick-Johnson Construction Co......Davenport, Iowa

Darling, W. A., Civil Engineer	Rock Island
Day, Wm. J., County Surveyor	Bement
Dolph, Orson, Surveyor	Yorkville
Doty, Duane, Civil Engineer	Pullman
Dubuis, O. F., Landscape Engineer	Peoria
Dunn, Chas. H , Civil Engineer and County Surveyor	Peoria
Elliott, C. G., Publisher *The Drainage Journal*	80 Baldwin Block, Indianapolis, Ind.
Ellsworth, Chas. E., County Surveyor	Danville
Enos, Allen, Civil Engineer	Springfield
Enos, Z. A., Civil Engineer	Springfield
Ericson, John, City Engineer	City Hall, Chicago
Evans, Wallace C., Civil Engineer and Contractor, 100 Y. M. C. A. Bldg.,	Peoria
Feeney, William P., Surveyor	461 Washington Boul., Chicago
Fischer, Louis E	Danville
Folsom, Elmer, City Engineer	Bloomington
Gastman, G. W., Surveyor	Hudson
Gates, A. W., Civil Engineer Monmouth Mining & Mfg. Co.	Monmouth
Gerber, Winfred Dean, Civil Engineer	Rockford
Goodenough, Geo. A., Assistant Professor of Mechanical Engineering	University of Illinois, Urbana
Gordon, Daniel, Civil Engineer and Surveyor	Moline
Graham, Geo. W., City Engineer	Freeport
Graves, Edward A., Civil Engineer	Streator
Greeley, Frederick, Surveyor	822 Opera House Block, Chicago
Hallet, H. Dow, Civil Engineer and Contractor	Aurora
Harman, Jacob A., Civil Engineer	Peoria
Hay, W. M , Civil Engineer and Surveyor	Sandwich
Herron, W. H , Topographer U. S Geological Survey	Washington, D. C.
Howard, S. N., Surveyor and Secretary Greely Howard Co.	822 Opera House Block, Chicago
Holmes, C , County Surveyor	Macomb
Huggins, D. E., Superintendent of Water Works	Streator
Huston, R. C., Surveyor	Room 1, County Building, Chicago
Jansen, D. H., City Engineer	Pekin
Jaffray, J. R., County Surveyor	Belvidere
Jones, Lloyd Z , Surveyor	Galva
Jones, W. D., Civil Engineer	127 Hartford Building, Chicago

Kirkpatrick, H. B., Instructor in Civil Engineering........University of Illinois, Champaign
Knight, Philip C., Drainage Engineer and Surveyor........Pontiac
Ketchum, M. S., Assistant Professor of Civil Engineering........University of Illinois, Champaign
Kuehn, A. L., Instructor in Civil Engineering.....University of Illinois, Urbana

Lemen, W. C., City Engineer........Paris
Loomis, Arthur C., City Engineer........Mattoon
Link, Rudolph, Manager Keuffel & Esser Co.......111 Madison Street, Chicago

Marean, W. A., City Engineer........Belvidere
Maury, Dabney H., Jr., Consulting Engineer and Engineer Peoria Water Works Company........Peoria
Mead, D. W., Civil Engineer....... 605 First National Bank Building, Chicago
Melluish, James G., Civil and Sanitary Engineer........222 Unity Building, Bloomington
Miller, S. W., Manager Pacific Flush Tank Co......84 LaSalle Street, Chicago
Miller, J. Ed., City Engineer and County Surveyor........Monmouth
Monserrat, N. D., Hocking Valley R'y Co........Columbus, Ohio
McAuley, John B., Civil Engineer........Galesburg
McClanahan, T. S., Surveyor and Civil Engineer........Monmouth
McLane, Cyrus D., Assistant Professor of Architecture........University of Illinois, Urbana
McNabb, John M., Surveyor and Drainage Engineer........McNabb

Nicolet, Chas. H., Engineer with M. & H. Zinc Co........LaSalle
Norlin, Fred, Surveyor........711 Opera House Block, Chicago

Orr, Robert E., Engineer E. J. & E. R'y........Joliet
Orwig, H. I., Land Dept. C. & N. W. R'y........Chicago
Oswald, Fridolin, Architect and County Surveyor........Alhambra

Paddock, Henry G., City Engineer........Moline
Parmley, Walter C., Civil Engineer........18 Burt Street, Cleveland, Ohio
Parr, James F., Assistant City Engineer........East St. Louis
Potter, W. G., Civil Engineer........1206 Benson Ave., Evanston
Price, J. T., Land Dept. C. & N. W. R'y........Chicago
Purington, D. V........4800 Kenwood Ave., Chicago

Quade, John C., Engineer with Western Tube Works........Kewanee

Ricker, N. Clifford, Professor of Architecture, University of Illinois, Urbana
Rossiter, F. C........Room 1, 91 Washington Street, Chicago
Rudolph, Emil, Surveyor........408 Opera House Block, Chicago

SCHMELTZER, J. FOSTER, Surveyor............Manteno
SERVISS, JOHN H., Civil Engineer............Closter, N. J.
SEXTON, CHESTER H., Engineer............Beardstown
SHEPARDSON, JOHN EATON, City Engineer............Kewanee
SHERMAN, LEROY K., Assistant Engineer Sanitary District, Chicago............466 LaSalle Ave., Chicago
SHIELDS, W. S., Civil Engineer and Surveyor....127 Hartford Building, Chicago
SIMS, LEWIS J., Drainage Engineer............Lincoln
SLOCUM, ROY H., Assistant in Applied Mechanics, University of Illinois, Urbana
SMITH, OWEN T., Engineer and Superintendent Water Co............Freeport
SNOW, T. W., Civil Engineer............Batavia
STEVENS, HUBERT A., City Engineer............Joliet
STEWART, JOHN T., Civil Engineer (U. S. Geological Survey)............Paxton
STOWELL, CHAS. C., Civil Engineer............Rockford

TALBOT, A. N., Professor of Municipal and Sanitary Engineering, University of Illinois............Urbana
TALLYN, L. L., Instructor in Civil Engineering, University of Illinois, Champaign
TARRANT, WM. H., City Engineer............Champaign
THOMPSON, A. D............Peoria
TRATMAN, E. E. RUSSELL, Associate Editor *Engineering News*............1636 Monadnock Block, Chicago
TREICHLER, WALLACE, Civil Engineer............Rock Island

VIAL, ROBERT C., Asst. Engineer, C. & W. I. R. R............LaGrange

WHITTAKER, E. H., Drainage Engineer............LaSalle

WHITLEY, NOAH, County Surveyor............Lockport
WINDES, FRANK A., Civil Engineer and Surveyor............Winnetka
WITHINGTON, J., Surveyor............Mattoon
WRIGHTMAN, GEO. F., Civil Engineer............Lacon

ZETER, JOHN, County Surveyor............Lincoln

HONORARY MEMBERS.

FROST, GEO. H............New York, N. Y.
GREELEY, SAMUEL S............Chicago
HODGMAN, F............Climax, Mich.

PAST PRESIDENTS.

Ira O. Baker	1886–87	Daniel W. Mead	1894–95
C. G. Elliott	1888–89	Charles C. Stowell	1896–97
Arthur N. Talbot	1890–91	Almon D. Thompson	1898–99
Samuel S. Greeley	1892–93	Charles C. Brown	1900

Henry G. Paddock........1901.

PROCEEDINGS

OF THE

SEVENTEENTH ANNUAL MEETING

HELD AT

JOLIET, ILLINOIS, JANUARY 22, 23, 24, 1902.

JANUARY 22, 1902. AFTERNOON SESSION.

The Seventeenth Annual Meeting was called to order at three o'clock by the President in Castle Hall in the Knights of Pythias building.

Hon. Richard J. Barr, Mayor of Joliet, made an address of welcome. It was responded to by Vice-President Emil Rudolph.

The President gave his address to the Society.

On motion by Mr. J. W. Alvord, the Society instructed the Executive Board to take up the question of printing papers to be read at the annual meetings, so that they may be sent out to members before the meetings for preparation of discussions.

The report of the Committee on Sewers was read by Mr. J. W. Alvord, Chairman of the Committee. It was discussed by the President and Mr. J. W. Alvord. The topic "The Shrinkage of Earth Embankments" was disscussed by the President and Messrs. A. L. Kuehn, B. J. Ashley and J. L. Clark.

A paper entitled, "Water Supply for Small Cities," by G. W. Chandler, was read by the author. It was discussed by Messrs. B. J. Ashley and J. W. Alvord.

A paper entitled, "The State Dam and Tail Race at Joliet, Ill ," by J. W. Alvord, was read by the author.

A paper entitled, "Practical Municipal Resurveys," by W. M. Hay, was read by the author. It was discussed by the President and Messrs. W. M. Hay, J. L. Clark, B. J. Ashley, J. W. Alvord and Emil Rudolph.

Adjourned until 8 o'clock P. M.

JANUARY 22, 1902. EVENING SESSION.

The report of the Committee on Roads and Pavements was read by the Secretary.

A paper entitled, "Paving Practice in Joliet," by H. A. Stevens, was read by the author. It was discussed by Mr. H. A. Stevens.

The topic, "Cause of Rumbling of Brick Pavements," was discussed by Mr. W. C. Lemen.

The topic, "Natural and Portland Cement Concretes for Paving Foundations," was discussed by Messrs. G. W. Graham, H. A. Stevens, B. J. Ashley, the President and Prof. Talbot.

A paper entitled, "Wagon Roads and Civilization," by Ira O. Baker, was read by the Secretary.

The topic, "Can Broken Stone Roads be Built in the Corn Belt of Illinois which will not be Picked to Pieces by the Sticky Mud," was discussed by Mr. J. L. Clark.

The topic, "Trench Filling," was discussed by the President, Prof. A. N. Talbot and Messrs. H. A. Stevens and J. C. Quade.

A paper entitled, "Concrete and Melan Arches," by L. K. Sherman, was read by the author. It was discussed by Prof. M. S. Ketchum and the author.

The topic, "What is the Best Method of Protecting Earth Embankment Slopes?" was discussed by the President, Prof. A. N. Talbot and Messrs. A. L. Kuehn and E. E. R. Tratman.

The topic, "How Can the Rusting of Nails and Spikes in Exposed Places be Checked?" was discussed by Prof. A. N. Talbot and Messrs. A. L. Kuehn, J. L. Clark and L. K. Sherman.

On motion of Mr. G. W. Chandler, the President was authorized to appoint a committee of three to report on nominations for officers for the ensuing year.

Adjourned until 9 o'clock A. M.

JANUARY 23, 1902. MORNING SESSION.

The report of the Executive Committee was read by the Secretary. It was as follows:

To the Members of the Illinois Society of Engineers and Surveyors:

GENTLEMEN: At the meeting of the Executive Board it was decided to make the following recommendations to the Society:

For the ensuing year the Secretary shall be allowed fifty per cent. of all receipts for advertising in the annual report in excess of $350 00. The rates are to remain the same as at present.

Papers submitted to the Secretary by members before the fifteenth of December are to be printed in synopsis and sent out to members so that they may prepare discussions.

It would be advisable for the Executive Board to meet at least once a year in addition to the meeting at the annual convention, in order to discuss business relating to the Society.

The annual dues for Members and Associate Members shall be four dollars for the year 1902, except that the dues for Members admitted during the year shall be two dollars.

The regular salary of the Executive Secretary and Treasurer shall be one hundred and fifty dollars for the year.

The Board has audited the accounts of the Executive Secretary and Treasurer and found them correct.

THE COMMITTEE.

The report of the Executive Committee was adopted.

The Secretary read his report for the year 1901.

The Committee on Nominations for Officers for the year made the following report:

To the Members of the Illinois Society of Engineers and Surveyors:

GENTLEMEN: The Committee appointed to report on nominations for officers for the coming year makes the following recommendations: President, H,

G. Paddock; Vice-President, E. E. Russell Tratman; Trustees, H. A. Stevens and M. S. Ketchum.

G. W. CHANDLER,
J. W. ALVORD,
J. L. CLARK,
Committee.

The Members recommended for office by the Committee were unanimously elected.

The matter of the place of the next meeting was taken up. On motion by Mr. J. C. Quade it was posponed until the evening session.

The report of the Committee on Paving Brick Specifications and Tests was read by Prof. A. N. Talbot, Chairman of the Committee. It was discussed by Prof. A. N. Talbot, Messrs. H. E. Beasley, J. C. Quade and the President.

The Society adopted the report, discharged the Committee, and gave a vote of thanks to the Committee and Prof. A. N. Talbot in particular for their efforts in this matter.

The report of the Committee on Surveyors' License Legislation was read by Mr. S. S. Greeley, Chairman of the Committee. The report was adopted by the Society. A vote of thanks was given to the Committee and Mr. Emil Rudolph for their efforts in this matter.

A paper entitled, "One of the Objections that Helped to Defeat the Surveyors' License Bill," by W. P. Feeney, was read by the author. It was discussed by the President, Messrs. W. P. Feeney, S. S. Greeley, J. C. Quade, J. G. Melluish, F. C. Rossiter, B. J. Ashley, W. M. Hay, and Profs. A. N. Talbot and M. S. Ketchum.

Adjourned until 8 o'clock P. M.

JANUARY 23, 1901. EXCURSION.

At 1:15 P. M. a special car was provided by the Chicago & Joliet Electric Railroad on which the Members of the Society were taken to Lockport to visit the controlling works of the Sanitary

Canal. On returning to Joliet a visit was made to the plant of the Economy Light and Power Co. A number of members also visited the Garbage Crematory.

JANUARY 23, 1901. EVENING SESSION.

A paper entitled, "Steel Frame Mill Buildings," by M. S. Ketchum was read.

The question of selecting a place for the next meeting was taken up. Invitations were extended by the City of Bloomington and the University of Illinois. The cities of East St. Louis, Aurora and Peoria were suggested by members. On vote it was decided to hold the next annual meeting at Aurora.

A paper entitled, "The Purification of Sewage," by W. S. Shields, was read by Mr. W. G. Potter. It was discussed by Messrs. J. W. Alvord, W. C. Lemen, W. G. Potter, and Prof. A. N. Talbot.

The following resolution was introduced by Mr. E. E. R. Tratman:

> *Resolved*, That in the opinion of this Society it is desirable that the United States Census should include municipal statistics in its inquiries, particularly those relating to the nature and extent of municipal public works.
>
> *Resolved*, That this Society is heartily in favor of a permanent census or other statistical bureau at Washington, which shall include in its staff experts in municipal engineering, finance, and allied subjects.
>
> *Resolved*, That a copy of these resolutions be sent to the Hon. William R. Merriam, Director of the Census, at Washington, and to our representatives in Congress.

This was adopted by the Society.

Adjourned at 9:30 P. M. to make a visit to the plant of the Illinois Steel Company. The members were taken on cars of the Joliet Street Railway Company to the Steel Plant.

JANUARY 24, 1901. MORNING SESSION.

A paper entitled, "Concrete Structures for Railways," by W. A. Rodgers, was read by Mr. E. E. R. Tratman. It was discussed by Mr. C. H. Nicolet.

The report of the Committee on Surveying was read by Prof. A. N. Talbot.

It was decided that the President appoint a committee of two surveyors, who shall draw up a suitable letter stating the importance of preserving surveying monuments. This is to be sent to County Clerks and County Surveyors of the State by the Secretary, with the request that the Clerk transmit it to the Board of Supervisors in Counties under Township organization and to the County Commissioners in Counties not under Township organization. The President appointed Messrs. C. H. Nicolet and J. G. Melluish.

The following resolution was adopted:

Resolved, That it is the sense of this Society that a bill for the licensing of land surveyors should have a provision stating that a licensed surveyor shall not be permitted to send a party into the field unless the one in charge is a licensed surveyor.

The report of the Committee on Railroads was read by E. E. R. Tratman, Chairman of the Committee. It was discussed by Messrs. A. L. Kuehn, J. M. McNabb and Prof. A. N. Talbot.

The report of the Committee on Exhibits was read by Mr. H. A. Stevens, Chairman of the Committee. It was as follows:

To the Members of the Illinois Society of Engineers and Surveyors:

GENTLEMEN: Your Committee on Exhibits desires to call the attention of all Members of the Society to the very excellent exhibit of engineering instruments, drafting tools, slide rules, and miscellaneous instruments of interest to the engineer, which the Keuffel & Esser Company has brought to these rooms for your inspection. Iinstruments of the latest pattern, as well as novelties and standard goods, are here in profusion, and the thanks of the Society are due to this enterprising firm for this exhibit.

Circular letters sent out to all members, requesting an exhibit of the local materials of construction, as sand, gravel, stone, brick, etc., from the various districts represented by our members, have met with a very indifferent response. It was the belief of the Committee that such an exhibit would provide an opportunity for an intelligent comparison of some of the common materials of ordinary engineering construction as found within the different portions of this State, and would prove instructive and entertaining. Your Committee urges that a further effort be made to secure a full exhibit of this nature for our next annual meeting.

H. A. STEVENS,
Chairman.

The report was adopted by the Society.

A paper entitled, "Records of the Maintenance of Way Department of the Rio Grande, Sierra Madre & Pacific Railway," by Mr. L. P. Atsood, was read by Mr. E. E. R. Tratman.

The following resolution was presented by Prof. A. N. Talbot:

Resolved, That in consideration of the many courtesies extended to us by the officials and citizens of the City of Joliet, the Paul Revere Lodge of the Knights of Pythias, whose halls have been so generously placed at our disposal, the Joliet & Chicago Electric Railway, who furnished us with transportation to the various points of interest, the Joliet officials of the Illinois Steel Company, the Economy Light & Power Company, and the Sanitary District of Chicago, we hereby express our sincere thanks and appreciation of these courtesies, which have so materially aided in making this meeting one of the most interesting and profitable in the history of the Society. Be it further

Resolved, That we express our appreciation of the very successful efforts of our local member, Mr. H. A. Stevens, in making the arrangements for this meeting, and for the many excursions which have been enjoyed so much by the members. The Secretary to be instructed to transmit these resolutions.

The resolution was adopted by the Society.

A paper entitled, "The Location and Construction of an Interurban Electric Railway," by C. C. Stowell, was read by the Secretary. It was discussed by Mr. A. L. Kuehn.

On a motion by Mr. J. G. Melluish, the Society decided to drop the question of the promotion of state legislation for the licensing of surveyors.

The Executive Board was instructed to take up the question of the advisability of issuing certificates of membership to members.

The officers for the year were installed, Mr. H. A. Stevens presiding. He announced the election of A. L. Kuehn as Executive Secretary and Treasurer.

It was decided that in case the Executive Board should find it impracticable to hold the next meeting at Aurora, they select such other place as they may find proper.

Adjourned.

CONSTITUTION AND BY-LAWS

OF THE

Illinois Society of Engineers and Surveyors

AS AMENDED AND ADOPTED AT THE FIFTEENTH ANNUAL MEETING
HELD AT MOLINE, JANUARY, 1900.

CONSTITUTION.

ARTICLE I.—NAME.

This Association shall be called the Illinois Society of Engineers and Surveyors.

ARTICLE II.—OBJECTS.

The objects of this Society are the encouragement of professional improvement and of goodfellowship among its members, by meetings for the presentation and discussion of papers on scientific and other kindred topics, and the discussion of such other subjects as may be of interest to its members; the publication of such parts of its proceedings as may be deemed expedient; and the collection and preservation of books, maps, drawings, and other articles of value to the professions represented in its membership.

ARTICLE III.--MEMBERSHIP.

SECTION 1. Any engineer, architect, surveyor or person directly engaged in the designing, construction or maintenance of engineering or public works is eligible to membership; and any person who is engaged in the sale or manufacture of any supplies or materials used in engineering construction is eligible to associate membership.

SEC. 2. Each candidate for membership or associate membership shall make application in writing to the Executive Secretary on a printed form provided therefor by said Secretary. Such application shall state in writing the name, age, residence, present occupation and the nature and extent of professional service of the applicant; and must be endorsed by three members of the Society. The application shall be accompanied by a deposit of Three Dollars ($3.00) to be applied on account of the admission fee, if the applicant be elected, or refunded if he be not elected.

SEC. 3. Whenever any application for membership shall be received by the Secretary, a copy thereof shall be submitted to the members of the Executive Board within one month from date of the receipt of the same.

It shall be the duty of each member of the Executive Board within ten (10) days from the receipt of any such application, to send his vote upon the electing of such person to membership to the Executive Secretary. PROVIDED, that any applications received within two (2) months immediately preceding any regular meeting of the Society shall be submitted by the Secretary of the Executive Board at its session immediately preceding such meeting of the Society. Four (4) affirmative votes shall elect such person to membership.

The Executive Secretary shall include in his report to the Society the names and postoffice addresses of all persons elected.

SEC. 4. Any person may be elected an honorary member, by a unanimous ballot of all the members, not less than twenty in number, present at any regular meeting of the Society.

Honorary members may present papers and take part in all discussions, and shall be entitled to receive, on request made in writing each year, copies of the annual report of the proceedings of the Society, but they need pay no initiation fees nor dues, and shall have no vote.

SEC. 5. Any three members may present to the Executive Board charges in writing affecting the moral or professional character of any member, whereupon the said Board shall notify the member of such charges, and shall appoint a time and place at which the accusers and the accused may be heard. On an affirmative vote of at least four members of the Board, the charges shall be presented to the Society, as soon as it shall be in session, all parties being duly notified and having opportunity to be heard. On an affirmative vote of three-fourths or more of the members present, said affirmative vote being not less than eighteen in number, said member shall be expelled, and his name shall be struck from the roll; but no public notice of such proceedings shall be given.

SEC. 6. The annual assessment shall be due and payable in advance, and no publications of the Society shall be forwarded to any member till such annual dues be paid.

Any member who shall refuse or neglect for one year after the annual meeting to pay any dues or assessment due from him, shall cease to be a member, and his name shall be struck from the roll. He may be reinstated on payment of the sum so due and of all further sums which would have been due from him had he remained a member up to the time of such reinstatement.

ARTICLE IV.— OFFICERS.

SECTION 1. The officers of this Society shall be a President, a Vice-President, an Executive Secretary-Treasurer and Board of Trustees. The above named officers shall constitute the Executive Board, of which the President shall be ex-officio Chairman, and the Executive Secretary ex-officio Secretary.

Two Trustees shall be elected annually and hold office for two years.

SEC. 2. All officers except the Executive Secretary-Treasurer shall be elected annually by ballot by the members, on the second day of the annual meeting, and shall hold office until their successors are elected and qualified.

The Executive Secretary-Treasurer shall be elected annually by the Executive Board.

SEC. 3. The President, Vice-President, Executive Secretary-Treasurer, shall perform the duties usually pertaining to their several offices. The Executive Secretary-Treasurer shall be the custodian of all property of the Society, and shall deliver all such property to his successor, and shall make an annual report. He shall record the proceedings and discussions of the meetings, and shall prepare a copy of them for publication.

As Treasurer, he shall give bond with two approved sureties to such amount as may be required from time to time by the Executive Board, and his bond, when approved by said Board, shall be copied on the Journal of the Society, and be deposited with the President. He shall pay only such orders as have been signed by the President, Executive Secretary, and shall make an annual report of all receipts and expenditures, and shall deliver all the Society's books and money in his possession to his successor. The Executive Secretary, in addition to the duties usually pertaining to his office, shall be ex-officio Librarian of the Society, and as such shall collect and preserve all books, pamphlets, papers and documents belonging to the Society. The library of the Society shall be kept in some place central and convenient to access by railroad. He shall deliver all the property of the Society in his possession to his successor.

SEC. 4. The Executive Board shall audit the accounts of the Treasurer, and determine the assessment per member for the following year, immediately before each annual meeting, and make annually a report to the Society. They shall arrange the program of exercises for each annual meeting, and shall have a general care over the affairs of the Society, and shall act for the Society in all general matters between the annual meetings. No moneys shall be expended without a vote of the Executive Board.

SEC. 5. There shall be appointed at each annual meeting the following standing committees of three members each: (*a*) Committee on Surveying; (*b*) Committee on Roads and Pavements; (*c*) Committee on Railroads; (*d*) Committee on Water Works; (*e*) Committee on Drainage; (*f*) Committee on Sewers; (*g*) Committee on Exhibits; (*h*) Committee on Press. It shall be the duty of each committee to collate facts, figures and items of interest in their respective departments, and make at least one formal report to the Society at the annual meeting following their appointment. The chairman of each committee shall solicit, under the direction of the Executive Board, papers for the annual meeting, and advise with said Board in matters relating to the general subject of the committee's work.

ARTICLE V.—PUBLISHING ANNUAL REPORTS.

The Executive Board shall compile and publish the annual report of the transactions of the Society. They shall include in this report all items of general interest in the proceedings, and such other matters as may seem to them advisable.

ARTICLE VI.—COMPENSATION OF OFFICERS.

The Society may provide for the compensation of its officers for their services whenever deemed advisable.

ARTICLE VII.—AMENDMENTS.

All propositions for amendments of this Constitution shall be referred to the Executive Board, who shall report to the Society before final adjournment of the annual meeting, and such amendment shall be declared adopted by an affirmative vote of two-thirds of the members present, not less than fifteen members voting.

BY-LAWS.

SECTION 1. The annual meetings of this Society shall be in such place as shall be determined by this Society at each previous meeting, and at such time in January as shall be determined by he Executive Board. The Executive Board shall notify each member of the Society at least twenty days before the annual meeting.

SEC. 2. Ten members shall constitute a quorum for the transaction of business.

SEC. 3. The meetings of this Association shall be governed by "Roberts' Rules of Order."

SEC. 4. The order of business shall be fixed by the Executive Board.

SEC. 5. A record of all donations to the Society, whether in money, books, maps, models, or other articles of value, with names of the donors, shall be entered by the Executive Secretary in a book provided for that purpose.

SEC. 6. These By-Laws may be amended by a two-thirds vote of the members present at any annual meeting, not less than fifteen members voting.

PRESIDENT'S ADDRESS.

BY H. G. PADDOCK.

We are once more assembled for the laudable purpose of promoting the best interests, growth, and advancement of our profession, and I extend greeting to you with the sincere hope that you will find this meeting both interesting and instructive. That it will be so, I feel quite certain after looking over the program as prepared by the Secretary.

It is necessary, only, to look at the first topic to find a matter of vast importance to all of us. The question of a deep waterway from Chicago to New Orleans is a subject, not only of great interest to the Engineer, but a matter that is of consequence to the whole Mississippi Valley; in fact, it is of consequence to almost the entire United States. The time is not far distant when the increased density of population will make it necessary to follow in the footsteps of the older European nations. It will be a commercial necessity, not only to connect the Mississippi with the Great Lakes by a waterway that will be navigable for all sizes of craft, but to so improve the channel of the Mississippi and other rivers by a system of canals or otherwise until all are in as near perfect a condition for navigation as is possible. The building of canals will become a necessity, as far as practicable, in all commercial lines. The Hennepin Canal is an example of this. Although certain interests succeeded in fixing such dimensions for it that it will only accommodate very small boats, its construction will solve the engineering problems and demonstrate how much greater advantage it would be to the country if it was large enough to carry any sized vessel, particularly if the deep waterway should be constructed from Chicago to New Orleans via the Illinois river. The engineering problems having been solved, the Engineer will be enabled to make an estimate of the expense of enlarging the Hennepin Canal to a ship canal with such accuracy that Congress will feel assured that it will not be called upon to make an additional appropriation to finish the work; thereby simplifying the labor of the friends of the measure in securing the appropriation.

The presentation of the subject, "Water Supply for Small Cities," cannot fail to excite great interest; for perhaps no present day problem has any more vital importance and deserves more well-directed attention than this. Although Illinois is one of the well-watered states, there are very few of the cities that have solved the problem both as to quality and quantity of their water supply. In this connection in many of the cities the question of the purification of sewage must be faced. In some cities this is a matter independent of the water supply, but still none the less difficult to solve. The time will surely come when the cities along the large waterways will be forced to purify their sewage before discharging it.

The subject of good roads has been for many years one in which most of the members of our profession were interested, either directly or indirectly; and it will continue to be so for some time. Good roads in the country are just as necessary to the best development of the farming lands as good streets to the needs and industries of the city. In both, expenditure of money for improvements is a profitable investment when it is not so much as to be a burden to property owners and taxpayers.

In most cities the surface of the first streets was the original ground surface. As soon as there was any considerable travel, the low places were impassable, except while the ground was frozen or during very dry times. In a short time public sentiment demanded that something be done to improve the streets. Then it was decided by the authorities to raise the low portions of the streets out of the water by scraping up earth in these low portions, making a pike with a depression on each side in which water stood the greater part of the summer. This pike was cut by deep ruts by the travel in wet seasons. The next step was to put rock or other hard material on the pike, making an effort quite often to remove the water at the sides by digging open ditches and sometimes by underdrainage. At times, in some of the more progressive cities which were fortunate enough to have the materials at hand, macadam or gravel was put on in a fairly workmanlike manner with comparatively good drainage. Experience demonstrated that the cost of keeping in repair any considerable amount of macadam or graveled streets soon reached the point where the total revenue available for street improvements was consumed in repairs, leaving nothing for extensions. This led the progressive city to make investigations with a view of adopting some material which did not require such expensive repairs, and at the same time not have too high a cost. Such investigation resulted in the adoption of brick in most localities within a reasonable distance of a factory. Special assessment laws enabled the cities to pave with brick their principal thoroughfares and side streets in the more thickly settled portions. The success of the brick for pavement forced a reduction of the price of asphalt so that at the present time, in most localities, those preferring asphalt can obtain it at a price only slightly higher than brick.

The history of the improvement of the country road has already practically followed the city street up to and a little into the macadam and gravel stage. Owing to the much greater frontage for each owner in the country, the present cost of a brick roadway seems to be practically prohibitory in almost every locality. Therefore, it would seem that the price of brick must either materially decline or Yankee ingenuity discover some other suitable but cheaper material before the country roads can be put in a condition equal to the city streets.

The laws of the State of Illinois provide that a township may vote to levy a tax for road improvements of not to exceed one dollar on each hundred dollars, for a number of years, not exceeding five, if petitioned to do so; provided, that the petition must state the location of the road, or roads, not to exceed two. It would seem that an affirmative vote would be hard to get, and that there should be a provision in the law that some portion of the cost of the improvements (say one-half) must be paid by special assessment on the property benefited. If the petition for the road were to be signed by the owners of one-half of the frontage along the proposed road, public-spirited men would be enabled to make a start in the township. This would go far toward removing the objection that a voter might have against voting for the tax under the present law. A voter who does not live along the line of the proposed road naturally thinks that it would be more just for the owner of the land along the road to pay a greater share than he. In the meantime the Engineer must use his influence to get the best results obtainable under the present conditions. However, he must not be disappointed if he fails to accomplish within a short time any radical improvements in the construction of roads, as nothing which the Engineer is called upon to do requires more diplomatic skill than is necessary to convince the average man in authority that his methods are wrong.

The report of the Committee on Surveyors' License Legislation will give some of the reasons why such a bill failed to pass. Nothing was developed in the efforts to have a bill passed, however, to indicate that this Society was not in the right when it favored the passage of a surveyors' license bill. The active advocates of the measure, whatever they may have thought when they first undertook the matter, became fully convinced that the time is not far distant when a bill will be introduced in the Legislature devising some form of a surveyors' license law that will be acceptable to a majority of the Legislature and much better for the people than the present county and irresponsible surveyors.

In conclusion, I would like to make a recommendation on the subject of printing our papers in advance of the meeting. Members wishing to discuss a paper read before this Society have no knowledge of the details of the writer's treatment of the subject. It has occurred to several of our members that, if the various papers to be read could be printed and copies put into the hands of each member before the meeting, it would enable those who wished to take part in the discussion to be better prepared. Therefore I would recommend that the propriety of having the papers printed in time to send each member a copy before the meeting, be referred to the Executive Board with a request that they investigate the feasibility of the matter, and, if possible, report during this meeting.

CONCRETE STRUCTURES FOR RAILWAYS.

BY W. A. ROGERS.*

In this paper the author will attempt to give briefly a statement regarding the classes of structures being built of concrete on the different railways in the central and western portion of the United States, a short statement of the general practice as to the proportions and qualities of materials used, and a few of the reasons which have led to the increasing use of this form of masonry. During the past few years the use of concrete in the construction of the various railway structures has increased materially.

Vast sums have been spent and are being spent in the improvement of railway properties. One form of this improvement has been a substitution of masonry structures for temporary wooden bridges and culverts. On account of the increased weight of rolling stock, the rebuilding of many bridges has been made necessary. The idea that iron and steel bridges are permanent has been proved a misconception, and some of the more important railway lines are said to be adopting the policy of constructing masonry arches in place of steel girder spans where the location is suitable. Concrete has been largely used in each of the foregoing cases. The growing scarcity of timber has had the effect of increasing the use of concrete masonry, especially where economy is an object. These reasons, and the growing confidence brought about by its successful use, have led to its largely increased adoption during recent years.

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As intimated, the use of concrete for the ordinary pier and abutment is becoming very common. The author knows of piers and abutments up to 40 feet in height, built entirely of Portland cement concrete, which are giving very satisfactory service. He knows of concrete piers and abutments used to support high trestles and long spans, in streams where there is much ice. In fact, cement concrete is used in all ordinary railway bridge work where stone masonry was the practice in the past. Concrete is an ideal form of masonry for arch construction, and railroads are using it more and more for work of this character. It is especially good for the construction of skew arches, as it avoids the necessity of difficult work in cutting arch stones. Concrete arches of from 4 or 5 feet to spans of 100 feet are being built. In the larger spans steel in some form is ordinarily used to reinforce. The company with which the writer is connected has recently completed a concrete arch bridge composed of 8 spans ranging from 88 feet to 122 feet. This is, however, a city bridge, but it serves to illustrate the possibilities of this form of material. One of the western railroads has now in process of construction, the writer is informed, a number of arches of spans from 40 feet to 140 feet.

Rail and I-beam top culverts built of concrete are a common form of construction on a number of railroads in this vicinity, and this is a very desirable and economical form of culvert. The rails and I beams are ordinarily partially or entirely surrounded by concrete. The concrete circular or barrel-shaped culvert is used to a limited extent.

Many retaining walls have been and are being built of this form of masonry. Concrete is also used for cinder pit walls, turntable pit walls, sewers, all classes of buildings and bridge foundations, bumping posts, and freighthouse floors where there is a large amount of trucking. Recently it has been used for the entire walls of depot and shop buildings. Late issues of engineering papers describe the Northern Pacific Railroad depot at Fargo, North Dakota, and the shop buildings of the Central Railway of

New Jersey, which are built of concrete. In the author's opinion this last mentioned is capable of considerable development.

The materials used in the manufacture of concrete structures previously mentioned are those in ordinary use, viz: Natural and Portland cement, sand, and broken stone. The use of Natural cement is largely confined to concrete placed in foundations below the surface of the ground. It has been successfully used in times past above the surface, but there are enough instances of Natural cement concrete damaged by the action of the frost to make it unwise to use it in situations where it is exposed to frost. The difference in cost between the two classes of concrete is so slight with the present prices of cement that it is not worth the risk. The proportions ordinarily used for Natural cement concrete range from 1 part of Natural cement to 1½ parts of sand to 4 parts of broken stone, to 1 part of cement to 2 parts of sand to 5 parts of broken stone.

Portland cement concrete is used for all classes of structures. The manufacture of Portland cement has increased largely during the past few years, and it is now possible to get very good cement in the middle West. Ten years ago it was customary to specify imported Portland cement for important work; a little later cements from one or two well-defined districts in the East were used. The increased demand in the West has so stimulated the cement industry that it is now possible to get good Portland cement with a shorter haul. This, with improved methods of manufacturing, has had the effect of cheapening the cost to the consumer of this important material, resulting in increased use of concrete. The proportions ordinarily used in railroad Portland cement concrete work range from 1 part cement to 2 parts sand to 4 parts broken stone, to 1 part cement to 4 parts sand to 9½ parts broken stone, depending upon the character of the structure.

Sand is ordinarily specified and the material found on the line of the road is taken. Clean, sharp, and coarse are the qualities commonly called for. As to the first quality, the term as used is relative, and the strictness with which the term is used is varied on the different lines. There seems to be a tendency where other qualities are good to use a sand or gravel that is not, strictly speaking, clean. In the opinion of the author this is justified by results, not only of laboratory tests, but by experience with actual work. Experiments seem to show that sand containing a moderate amount of clay or loam makes good concrete. Coarse sand is ordinarily specified, yet there is a tendency to accept the best that can be had along the line of the road in question. It is more or less a question of strength. A very fine sand will not produce concrete which is as strong as that made with coarse, sharp sand. Screenings from hard, crushed limestone are used by certain railroads in place of sand with very good success.

The substitution of gravel in the place of sand is quite customary, the relative proportion of sand and stones in the gravel being determined and enough broken stone added to make the required proportion of materials. Crusher-run broken stone is becoming common practice where the finer portions are hard and sharp. Where the stone is not hard enough to use crusher-run, the finer portion is ordinarily screened out. The maximum size specified is 2 inches to 2½ inches. Cinders and slag are sometimes used, and one of the Western roads where stone is scarce has reported using burnt gumbo in place of broken stone.

The practice in the manufacture of concrete for railway structures is tending toward the wet mixture. In the ordinary abutment and pier work the practice is working toward concrete without a special mortar facing, the smooth surface being obtained by spading, or some other satisfactory operation. Stone bearings for spans of ordinary length on concrete abutments and piers are being abandoned by many. In some instances a stronger concrete is made for the bearing, but in many cases no distinction whatever is made in proportion of materials for the tops of piers and abutments.

In this connection the author would like to emphasize the necessity of careful workmanship in the manufacture of concrete. The proportions of materials, especially the cement and sand, should be carefully measured, and as much stone added as the mortar will properly cover. Careful mixing of the materials should be the rule. It is poor economy to save on labor of mixing. The idea that concrete is a cheap form of masonry is so general that we are apt to want to still further cheapen it, and the temptation is to cut down on the labor item by slighting the mixing. This policy when followed is suicidal. All of our care in selection of first-class materials is wasted if we slight this feature. The author believes that much harm is apt to result to the cause of concrete because of the want of care exercised in its manufacture. The idea has become too prevalent that anyone who can push men can mix and place this form of masonry. The concrete foreman should be an expert. While looks do not necessarily add to the durability or usefulness of a structure, the writer believes that engineers should be willing to pay enough for their work to permit of making a nice-looking job in keeping with the purpose to which the structure is to be put.

Let us lastly consider some of the reasons which have led to the increasing use of concrete by the railroads. The fact that it can be built with unskilled labor, under a competent foreman, is an important advantage, as is also the ease with which suitable materials may be obtained and the readiness with which it may be moulded in different forms. In the present condition of the steel market, when it takes from eight months to a year to get delivery of steel bridges, concrete arches of long span are being planned and built in places which would ordinarily be crossed on steel girders, because they can be completed long before steel could be furnished. Concrete construction is ordinarily cheaper than stone, and with the present price of materials it will be found that frequently concrete arches may be built for less money than steel on masonry abutments. Properly made, concrete is durable. Concrete is susceptible of such treatment as to present a pleasing appearance, adapting it to various forms of building work. In bridge work it can be built with less interference with traffic than stone masonry. The writer believes that there is a rapidly growing sentiment in favor of concrete structures that is well merited.

DISCUSSION.

MR. C. H. NICOLET: One item which was not touched upon in the paper, and which seems to the speaker to be a very essential thing in the manufacture of good concrete, is the tamping. The company with which the speaker is connected put in some three thousand yards of concrete in the last four of five years, and it was largely under his care. At first tamps were made that weighed about thirty pounds, and these were used with fair success; but later tamps weighing fifty pounds were used, producing much better results. The speaker first thought that all that was necessary was to agitate the material in order to work the mortar into the voids, but after considerable experience he finds that thorough tamping is absolutely necessary. If a light tamp is used the workman goes over the work in a half-hearted way; he must lift the heavy tamp, and merely dropping it produces a much better result. The concrete on this work was laid in six to nine inch layers, producing very good results.

Another important point is in regard to the use of screenings in place of sand. The speaker made some experiments to determine the relative values of screenings and sand. Briquettes made up with sand gave a strength of about five hundred pounds, while those made up with screenings gave about eight hundred pounds. The proportions used were one part of sand or screenings to one part of cement. Almost invariably briquettes made up with screenings gave a strength equal to or greater than those made of neat cement. This result seems strange. The number of experiments does not warrant the statement that briquettes made up with screenings will always give a strength greater than those made of neat cement, yet it is safe to say that they will very nearly give an equal strength.

No facing was done on any of the work, the face being obtained by simply leaving out some of the coarse stone. The proportion used on some of the most important work was one wheelbarrow of screenings, five of material that would pass through a half-inch mesh, and five of material that would pass through a two and a half inch ring, together with two sacks of cement. It was found that a wheelbarrow heaped in a certain way contained two cubic feet, so that the proportion was about one, five, five, five; however, since the screenings and the stone when mixed were reduced in volume about twenty per cent, the ultimate proportion was about one, four and a half, nine. When there was to be a face, about one barrel of the coarse stone was left off, and with proper tamping the voids were so nearly filled that the face was quite smooth. About one and a half to one and three quarters cubic yards of concrete were obtained for each barrel of cement.

CONCRETE AND MELAN ARCHES.

BY L. K. SHERMAN.

COMPUTATION.

The methods in common practice for the design and computation of stresses in voussoir arches are recognized as unsatisfactory. These methods are still more unsatisfactory when applied to concrete and Melan arches.

The main trouble arises from the attempt to compute the stresses in an arch by means of the principles of statics, when an arch is a statically indeterminate structure. The one exception is the three-hinged arch. In this paper will be considered only arches without hinges.

The common process for computing arches is briefly as follows: *First,* Compute the horizontal thrust at the crown necessary to balance the moment of the outer forces about the abutment or about a joint of rupture considered as a hinge. *Second,* Apply the horizontal thrust at the crown at some point within the middle third of the arch ring and draw a line of resistance, revising the section if necessary so that the line of resistance will keep within the middle third of the arch. In this process the real point of application of the crown thrust is unknown and has to be assumed.* The crown thrust is horizontal only when the loading is symmetrical each side of the center. When the loading is not symmetrical the direction of the crown thrust is unknown, and the common method is mere guess work.

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* Prof. Swain has presented an article in Van Nostrand's Magazine on Dr. Winkler's theorem, "The true line of resistance is the one lying nearest the center of the arch ring."

The joint of rupture is considered as hinged when, as a matter of fact, in concrete and Melan arches it is not hinged but has a bending moment that replaces considerable of the otherwise necessary crown thrust. In Melan arches the dead load may not be small in comparison to the live load. Arches tested to destruction failed not when loaded uniformly but when the load was applied to half the span. Therefore it is proper to consider unsymmetrical loading, and it is essential to do so in the case of Melan arches, or light arches with little spandrel filling.

Having criticised the common method of computing, we will consider another method.

The " Elastic Theory " for the calculation of arches was first presented to general notice by Weyrauch, in 1879. This method is based on the well-known law that " the stress is proportional to the strain for homogeneous materials within the working limits of stress." The most valuable investigations that have been made on arches are a series of tests made by the Austrian Society of Engineers and Architects. Numerous abstracts of these tests have been published.* We will give here only an outline of the results. Tests were made on five arches, all of which had a span of 75.4 feet and a clear rise of 15.1 feet. They are as follows:

		THICKNESS.		ULTIMATE LOAD.
	MATERIAL.	Crown.	Skew-backs.	Pounds per sq. ft. Over half-span.
1.	Rough Quarry Stone	23.6 in.	43.3 in.	660
2.	Brick	23.6 in.	43.6 in.	602
3.	Concrete	27.6 in.	27.6 in.	742
4.	Melan	13.8 in.	23.6 in.	1,300
5.	Steel	.....	.....	1,564

The very important conclusion drawn from these experiments by the Austrian Society was that masonry arches behaved very nearly as elastic arches fixed at the ends. Also, that all large arches should be designed according to the Elastic Theory.

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* See " A Treatise on Arches," by M. A. Howe, 1897; also *Engineering News*, November 21, 1895, and April 9, 1896.

Prof. Baker, in his "Treatise on Masonry Construction," has stated several objections to the application of the "Theory of Elasticity" to arches. These objections will not apply to concrete arches. The objection that the loading cannot be determined exactly, which Prof. Baker makes, applies equally to all other theories of the arch. In fact, this applies more or less to the designing of all structures.

Probably the real drawback to the use of the "Method of Elasticity" has been the somewhat formidable array of mathematical formulæ. Nevertheless, a long way is better than a wrong way, and to make calculations is partly what engineers are for.

However, it is not necessary to wade through the calculus to use the formulæ. The "Method of Elasticity" has been proven correct by experiment, which is the most satisfactory proof possible.

The best work on the computation of arches that the writer knows of is "A Treatise on Arches," by Prof. M. A. Howe. The formulæ which Prof. Howe presents are based on the Elastic Theory, and are in such shape as to be readily applied in practice. Numerous tables assist in the labor of performing the reductions for any case. The accompanying diagrams were platted with points computed from Prof. Howe's formulæ:

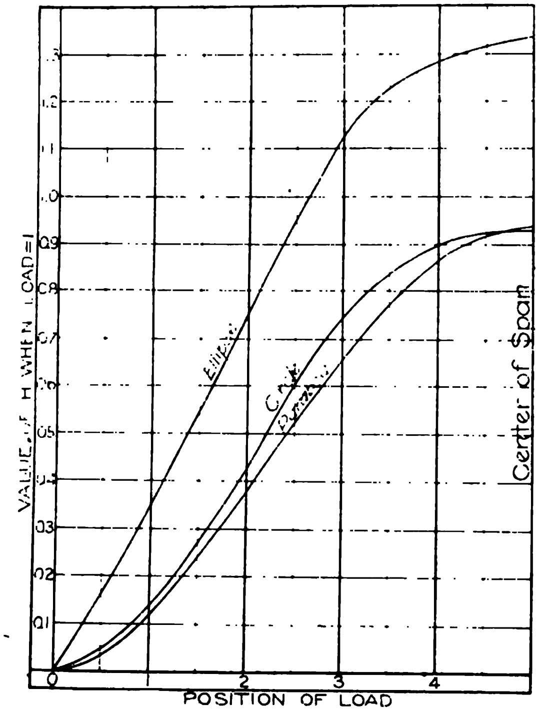

FIG. 1-RISE—$\frac{1}{4}$ SPAN

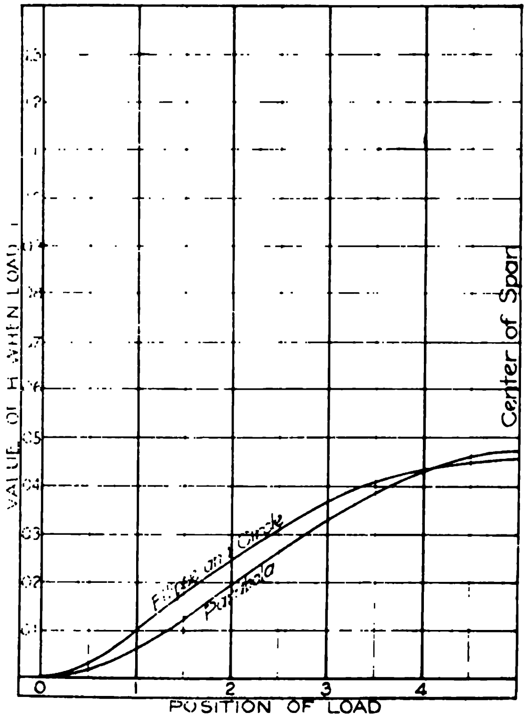

FIG 2-RISE—$\frac{1}{2}$ SPAN

DIAGRAMS OF HORIZONTAL THRUSTS FOR ARCHES.

NO HINGES. LOADS VERTICAL.

Figure 1 is a diagram of horizontal thrust for three arches which were computed by the author by the "Method of Elasticity." The rise is one-fourth of the span, loads are vertical, and axial stress neglected. The elliptical arch has a thickness at the abutment equal to 1.22 times the depth of the arch ring at the crown; the circular arch has a uniform thickness; the parabola at springing is 1.12 times the thickness at the crown. These curves are the centers of the arch rings. The diagram can be used to find the horizontal thrust for any sort of loading. For example, let it be required to find the horizontal thrust for a single load placed at a distance of three-tenths of the span, arch circular, rise one-fourth span. The result is read off of diagram (Fig. 1) directly. The thrust is 0.75 times the load. The total thrust for a uniform load is twice the area included between the curve and the line for the middle of the span. The thrusts shown by these curves are for any span of arch of its type when the rise is one-fourth of the span.

The horizontal thrusts for the parabola of the type illustrated (moment of inertia of arch section times the cosine of central angle is constant) are inversely proportional to the rise. A comparison with the diagram of thrusts for arches where the rise is one-half the span (Fig. 2) illustrates this. Hence the curve of thrusts in Fig. 1 can be used for a parabolic arch of any span when the cosine of the central angle is a constant.

The horizontal thrusts for the circle are not exactly proportional to the rise. For all practical purposes an interpolation between the curves drawn for maximum, minimum, and intermediate rise of arches would give the horizontal thrust for any arch. In a similar manner curves can be made for the bending moment at the springing. Then, having found the horizontal thrust and the moment at the springing, the stresses at any point on the arch are readily found either graphically or algebraically.

The author wishes to emphasize: *First*—"The Method of Elasticity" is the proper one for computation of arches of either steel or masonry. *Second*—For simplifying computations by the

"Method of Elasticity," a series of diagrams can be made similar to those illustrated which would cover any type or any shape of arch. With such an arrangement the stresses in an arch could be computed as quickly and as accurately as the stresses in a truss bridge of the same span.

The diagrams are suggested as being preferable in practice, as there is little liability of numerical errors and checks and comparisons are readily made.

DESIGN.

The rise of an arch is generally fixed by the distance of the roadway above the stream or crossing. The shape is governed by the ratio of rise to span and the architectural effect in relation to the surroundings. The thickness of the ring of fixed arches should increase from crown to abutments. The three-hinged arch should be thickest theoretically at the haunches. A fixed arch is more rigid and free from vibration than a hinged arch. The fixed arch should be used wherever a solid foundation exists. If, however, there is danger of any movement of the abutments the three-hinged arch should be used; for any slight movement of the abutments of a fixed arch makes a decided change in stresses and may produce cracks. Among European Engineers it is general practice to leave joints or temporary hinges in the arch during construction. After the centers are removed the joints are closed up, and the arch acts as fixed for additional or live loads. The idea is to keep the line of resistance definitely located at the hinges in spite of the stresses that are set up by the sag of the arch when centers are removed.

The author does not consider that temperature stresses demand hinges in any type of arch. It is proper, however, to consider the stresses due to temperature. Temperature changes may cause a crack in the spandrel wall over the springing, and it is well to provide this wall with a joint. Prof. Pence, in a paper before the Western Society of Engineers, gives the co-efficient of expansion of concrete as .0000055 per degree Far. The success that has been met with in combinations of concrete and steel is due largely to the fact that there is not a great difference between the co-efficients of expansion of the two materials, and also that there is a remarkably strong adhesion of cement to iron, from 400 to 600 lbs. per sq. in.

Having found the maximum shears, thrusts, and moments at various sections throughout the arch, the next step is to check the stresses at the sections. In a concrete arch this process is essentially an application of the method used in applied mechanics for a short strut with eccentric load; that is, the maximum stress is the algebraic sum of the thrust uniformly distributed over the cross section and that due to the moment of the thrust about the neutral axis. In a Melan arch the principle is the same but the process is more involved on account of the determination of the proportions of the thrust carried by the embedded metal. Mr. Edwin Thatcher, M. Am. Soc. C. E., who has designed and built a large number of Melan arches, has presented the following formulæ* for symmetrical sections:

$$S_1 = \frac{T}{(A_1 + 20A_2)} \pm \frac{6\, d_1\, M}{(I_1 + 20I_2)}$$

$$S_2 = \left\{ \frac{T}{(A_1 + 20A_2)} \pm \frac{6\, d_2\, M}{(I_1 + 20\, I_1)} \right\} 20$$

S_1 = Stress in pounds per sq. in. in concrete.

S_2 = Stress in pounds per sq. in. in steel.

T = Thrust on section of arch one inch wide.

M = Bending moment for section of arch one inch wide in foot pounds.

A_1 = Area of section of concrete one inch wide.

A_2 = Area of steel rib divided by distance from center to center of steel ribs in inches.

I_1 = Momenr of inertia of A_1 about common neutral axis.

I_2 = Moment of inertia of A_2 about common neutral axis.

20 = Ratio of modulus of elasticity of steel to that of concrete.

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*See *Engineering News*, September 21, 1899, and April 25, 1901.

The principle on which these formulæ are based and which should be the basis for calculation of stresses in all composite structures of concrete and metal is this: suppose we have a rod of iron surrounded with a layer of concrete and subject to a tensile stress; at any section the bar will be elongated a certain amount and the surrounding concrete will be elongated the same amount. From Hook's Law the stresses are proportional to the strain within the working limits of the materials. Taking the Modulus of Elasticity of iron at 28,000,000 and the Modulus of Elasticity of concrete at 1,400,000, a pull which will elongate the composite bar 1-1,400,000 part of its length will cause a stress of one pound per square inch in the concrete and 20 pounds per square inch in the iron. The same thing holds true for the composite rod under compression, the stress in the iron being 20 times the stress in the surrounding concrete. Hence we have the following important principle for composite concrete and metal structures: The stresses in the concrete and in the metal are in proportion to each other as their respective Moduli of Elasticity. Mr. Thatcher has used the ratio of 1 to 20, and this is very nearly the figure determined by the Austrian Society of Engineers. Tests made on smaller specimens of concrete have given results which reduce this ratio.

Messrs. A. L. Johnson and A. L. Watson in the Proceedings of the Am. Soc. C. E. report some tests of concrete steel beams made at the Massachusetts Institute of Technology. Their results indicated that Hook's Laws did not apply exactly to composite beams; also that the metal carried a larger stress in tension, without cracking the concrete, than theory allows. This may modify the unit working stresses to be used, but the deviation of the tests is not sufficient to alter the above theory as a basis for investigation.

For preliminary calculations for thickness of concrete arches at the crown use Trautwine's rule:

$$\text{Thickness at Crown} = \frac{\sqrt{\text{Radius} + \frac{1}{2}\,\text{span}}}{4} + 0.2 \text{ ft.}$$

For Melan arches the thickness at crown may be reduced according to the amount of metal used. The following rule for preliminary purposes is proposed for Melan arches:

$$\text{Crown Thickness} = \left(\begin{array}{c}\text{Depth in}\\ \text{Trautwine's Rule}\end{array}\right) = \frac{\text{10 Area Iron Beams}}{\text{Hor. Dis. bet. Beams}}$$

MATERIALS AND CONSTRUCTION.

We will touch on the subject of concrete only so far as it applies specially to arches. Concrete for the arch ring should be made of first-class Portland cement, proportions not exceeding one part cement to seven of aggregates.

The concrete should be thoroughly tamped in layers six or eight inches thick.

Thorough mixing is necessary, and concrete is improved by mixing in proportion to the number of turnings beyond the amount usually given.

The amount of water to be used in concrete depends on the condition of the materials and on the weather. The author has had quite a wide experience on concrete construction and prefers a fairly wet, or quaking mixture, to a dry concrete. Voids in mortar and concrete are never entirely filled with cement and sand,* and a considerable excess of water can be carried by the concrete without reducing its density.

In an arch ring, however, the concrete should be a little drier than usual. This necessitates extra tamping.

If possible, the arch ring should be constructed without interruption in one section. Should conditions compel a delay, the work should be ended off in a radial line.

The facing mortar should be placed at the same time as the concrete and bonded with it.

A mortar composed of one part cement to three parts sand is as durable for facing as a one to two mixture, and is less liable to crack during the process of setting.

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*See *Engineering News*, January 9, 1902.

There is need for more definite methods of specifying the proportion of cement in mortar and concrete.*

While tests of cement and proper specifications are important, the most essential factor in securing first-class concrete is proper inspection, or supervision, during construction. Without this, the best set of specifications ever written are only waste paper. In Cooper's Bridge Specifications is stated "the most perfect system of rules, to insure success must be interpreted upon the broad grounds of professional intelligence and common sense."

This may be true, but the average contractor does not interpret specifications this way. While it is proper to have descriptive portions in a specification, yet, when it comes to the requirements, state what you want so there shall be no doubt, and stick to it. Do not call for work that you do not expect to carry out, or for work or materials that are beyond good general practice. Such procedure is unfair to different bidders for the work, and is a mean way of shifting your responsibility for the work on an inspector.

There are numerous patents in connection with concrete iron construction. Wherever the work involves the use of patent rights, and is to be let out to bidders on contract, it is best to secure the use of such patents beforehand, and not leave it to the bidders. Unless this is done one bidder is liable to have an unfair advantage over others, and the cost of the work will be increased from lack of competition.

GENERAL.

The principal advantage of the arch over a truss or girder bridge is in beauty and durability.

A concrete arch is cheaper than a stone arch nearly in proportion as concrete is cheaper than cut stone masonry. A Melan arch or a concrete arch reinforced with imbedded iron beams can

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*See *Engineering News*, January 9, 1902.

be so designed that it will be cheaper than the plain concrete structure. In addition, the Melan arch carries a large reserve force or factor of safety. Ordinarily, as has been explained, the full working value of the iron can not be used; but in case the concrete is fractured the full strength of the iron will be called into play and is capable of carrying a large load.

The question of relative cost between the arch and the steel truss is so dependent on local conditions that no general comparison can be made. There are many cases, when foundations are favorable, where the first cost of the arch will be less than the first cost of the truss. Moreover, the concrete arch utilizes local labor and materials to a greater extent than an iron bridge does.

There are cases, if durability, cost of painting, and repairs are considered, where the arch is more economical even though first cost is greater. We have examples of this on railroads building permanent structures. The Illinois Central Railroad has removed a number of iron bridges and replaced them by concrete arches.

The element of beauty is an important feature in parks, boulevards, and city streets. Aside from its utility an arch bridge can be a handsome monument to a town and a credit to its owners.

Following is a list of twenty-eight concrete and Melan arches, with statement of rise, span, and dimensions, and composition of arch ring:

LIST OF SOME CONCRETE AND MELAN ARCHES

	LOCATION	ENGINEER	TYPE	SPAN	RISE	RISE / SPAN	WIDTH	THICKNESS Crown	THICKNESS Skewb'k	Concrete Proport'ns	DATE
1	Belleville, Ill	Geisel	Concrete	40 ft	7 ft	$\frac{1}{5.72}$	52 ft	24 in.	30 in	1-3-5	....
2	Evergreen Road, Pittsburg, Pa	Melber	Concrete	28	4.08	$\frac{1}{6.87}$	20	......	......	......	....
3	Ill. Cent. R. R., Effingham, Ill	Parkhurst	Concrete	40	20	$\frac{1}{2}$	......	27	108	1 2-5	1900
4	Test Austrian Soc. Engineers	......	Concrete	75 4	15 1	$\frac{1}{5}$	6.56	27.6	27.6	......	1895
5	Danube River	......	Concrete (3 hinge)	141	14.36	$\frac{1}{9.81}$	15	39 36	51 12	......	1896
6	Imnay, Germany	......	Concrete (3 hinge)	98 4	9 84	......	13	17.76	......	1-2½ 5	1896
12	Wurtemberg, Germany (4 spans)	......	Concrete (3 hinge)	124.64	19 04	$\frac{1}{6.54}$	19	31 44	......	1 2½-5	....
13	Miltenberg, Germany (2 spans)	Fleishmann	Concrete (3 hinge)	112	17.7	$\frac{1}{6.33}$	23	27 6	31 68	1-¼ 3	1899
	Miltenberg, Germany (4 spans)	Fleishmann	Concrete (3 hinge)	107	......	....	23	29.52	33 48	1 ¼ 3	1899
14	Ehingen, Germany (1 span)	......	Concrete (3 hinge)	66	7 2	$\frac{1}{9.2}$	25	27 6	36	1-2½ 5	1898
	Ehingen, Germany (2 spans)	......	Concrete (3 hinge)	69	......	......	25	27 6	36	1-2½-5	1898
15	Eden Park, Cincinnati, O	Von Emperger	Melan	70	10	$\frac{1}{7}$	32 5	15	48	1-2 4	1895
16	Stockbridge, Mass	Von Emperger	Melan	100	10	$\frac{1}{10}$	7	8	36	1 2 4	.....
17	Widdegg, Switzerland	......	Monier	127	12 7	$\frac{1}{10}$	......	6 7	9 8	......	.....
18	Topeka, Kan (2 spans)	Keepers & Thatcher	Melan	110	16 3	$\frac{1}{6.75}$	37	22	28	1 2 4	1897
	Topeka, Kan (2 spans)	Keepers & Thatcher	Melan	125	18 9	$\frac{1}{6.62}$	37	22	28	1 2 4	1897
	Topeka, Kan (2 spans)	Keepers & Thatcher	Melan	97 5	......	......	37	22	28	1 2 4	1897
19	Atlantic Highlands, N. J	Melan Arch Const. Co	Melan	50	......	......	25	......	......	......	....
20	Paterson, N J	Thatcher	Melan	88.5	9 5	$\frac{1}{9.4}$	54	15	66	1-2-4	1898
21	Armour Bridge, Oconomowoc, Wis.	Hall, Staunsen & Blome	Monier	21	6 67	$\frac{1}{3.14}$	15	5	......	1 3-4	1898
22	Guayo R., Porto Rico (1 span)	Thatcher	Melan	70	7 5	$\frac{1}{9.35}$	18	......	......	1-2 4	1901
	Guayo R., Porto Rico (2 spans)	Thatcher	Melan	70	7	$\frac{1}{10}$	18	......	......	1-2-4	1901
23	Jacaguas R., Porto Rico (1 span)	Thatcher	Melan	120	12	$\frac{1}{10}$	20	28	......	1 2 4	1901
	Jacaguas R., Porto Rico (2 spans)	Thatcher	Melan	100	11.28	$\frac{1}{8.5}$	20	22	......	1 2 4	1901
24	National Park, Washington, D. C.	Melan Const. Co. and Geisel Co.	Melan	24	5	$\frac{1}{4.8}$	26	8	......	1-2-4	1901
25	Zoological Park, Washington, D. C.	Melan Const. Co. and Geisel Co.	Melan	80	14	$\frac{1}{5.7}$	34	18	......	1-2 4	1901
26	Test Stutgart, Germany	A Hoch	Melan	65 6	5 06	$\frac{1}{13}$	......	4¾	8¾	1-7½	1899
27	Test Austrian Soc. Engineers	......	Melan	75.4	15.1	$\frac{1}{5}$	6.56	13 8	23.6		1895
28	Indianapolis, Ind (6 spans)	Melan Arch Const. Co	Melan	74	9 5	$\frac{1}{7.8}$	70	16	......	1-2-4	1900

DISCUSSION.

MR. L K. SHERMAN: The speaker believes that 500 pounds per square inch is about the proper unit stress in compression. This makes a factor of safety of about five in the concrete. The allowable stresses, as was stated in the paper, are proportional to the Moduli of Elasticity. The Modulus of Elasticity of iron is twenty times that of concrete, and the working stresses should be in that proportion. When deformation takes place the concrete and the iron are distorted the same amount: however, the allowable stresses in the composite structure are governed by the allowable stresses in the concrete. If any part of the structure is compressed or extended a certain amount the stresses in the iron will be twenty times the stresses in the concrete.

In tension one writer allows fifty pounds per square inch; but others allow larger values—some as high as one hundred pounds. There seems to be quite a difference of opinion in this matter, but the speaker believes that it is best to design so that there will be no tension in the concrete.

The best proof of the Elastic Theory is that the tests of arches of seventy-five feet span, built to test this method, gave results which agree very closely with this theory.

PROF. M. S. KETCHUM: Quite a number of fixed masonry arches are being built in Germany at the present time as three-hinged arches. The hinges are made by placing sheets of lead between the ring stones at the springing and the crown. These sheets cover about one-third of the depth of the arch ring, the remainder of the joints being left open during construction. After the centers have been removed, and final settlement has taken place, the hinge joints are filled up and the arch becomes a fixed continuous arch.

This method of constructing fixed masonry arches removes a large part of the uncertainty as to the proper distribution of the stresses, and makes it possible to make quite an accurate solution of the stresses, the line of resistance being confined to the middle third at the crown during construction, and probably after the hinges are removed.

The lack of definite data, viz.: dead load, dimensions and character of backing, dimensions and kind of stone in the arch ring, etc., makes it very difficult to accurately apply any method of solution. In many arches, for example in short-span railway arches, the backing is oftentimes strong enough to support the entire load, and any method which omits this element of strength is certainly on the safe side.

While there is certainly much room for improvement in the present method of calculating the stresses in masonry arches, in view of the uncertainty in the data, materials, and workmanship, the speaker does not believe that the solution based on the Elastic Theory as proposed by Mr. Sherman, will be any improvement.

That Mr. Sherman seems to lack faith in the Elastic Theory is evidenced by his recommendation to design masonry arches so that there will be no tension in the masonry.

While the speaker believes that it is inconsistent to treat a masonry arch as an elastic body, he agrees with Mr. Sherman in his treatment of composite structures.

LOCATION AND CONSTRUCTION OF AN INTERURBAN ELECTRIC RAILWAY.

BY C. C. STOWELL.

This subject was selected, partially outlined, and assigned to the author to fill in the details. These details must necessarily be brief for two reasons: First, lack of extended experience in this kind of work; and, second, lack of time in which to arrange the details to make them of the greatest interest or value to the Society. The subject, however, is one of interest to the engineers and surveyors of the State and in the next few years will demand considerable attention.

Those of us who are accustomed to locate railway lines for economical operation and minimum expense in maintenance, the right-of-way being adjusted to the line, will find it hard to reverse this order and locate the line to fit the right-of-way, making expense of operation and maintenance the secondary consideration.

Probably the first feature that presents itself as peculiar will be that the right-of-way must be located before the center line of the track can definitely be determined. And if the ground is even ordinarily rough the center line must be curved and shifted in order that the slopes do not fall outside the right-of-way, or the grades become excessive.

The locating of the right-of-way, if conscientiously done, requires much time and the careful running of many section lines. In this work the lack of monuments is forcibly felt. If the railway chances to be along a highway marked out by the pioneers before the Government surveys were made, the work is much more complicated and can best be done by the county surveryor, who probably has notes to aid him. An experienced locating engineer will take many a side glance at better ground and deplore his cramped conditions; and, after working hard to do the best possible, he will feel that, after all, he has accomplished little.

A second peculiar feature that is sure to appear is, that the line, and in some instances the right-of-way, must be shifted to avoid shade trees. A house or other building may be moved, but trees must not be disturbed.

Where the line follows the side of a highway, the grade must be so adjusted as to leave all drive and gateways as nearly as possible in their original condition. Practically all conditions usually taken into account on steam roads to reduce time and power required to operate are left out of the work for an interurban electric line. The compensating of grades for curvature is entirely foreign to the subject. And, indeed, the tables usually given in field books to assist the engineer on location are as a language of which he has a limited knowledge. The tables of one degree curves for chords of 100 ft. can be used occasionally; but for curves having a radius of 100 ft. and 200 ft. they are sadly deficient. At the present rate of increase in electric interurban projects there will soon be a demand for a "long felt want" in the shape of a book of tables and formulas for this special work.

About the only feature that will seem natural to an engineer of railway experience in laying out an electric line is the care for the waterways. The grading, although light, is difficult and expensive owing to the narrow right-of-way. The liability of trespass upon lawns, flower-beds, and gardens by careless and indifferent teamsters is apt to bring on symptoms of some nervous disease, alike to contractor and engineer. The width of roadbed seems to be fixed at 12 ft. It is strange, in the light of experience on steam roads, that any less than 14 ft. should be thought of.

After material has been taken from a bank of 12 ft. in width, with which to surface the track, the shoulders together with a good portion of the slopes have disappeared, and they must be replaced from gravel trains at an early day at much greater expense than the additional cost of building a 14-ft. bank in the first place. The replaced slopes are by no means as permanent as when built with the main bank, and if not closely watched, rains will endanger the track.

The company with which the author has been associated the past season put in excellent material in the track with the idea of occasionally giving trackage to locomotives and hauling freight cars from steam roads. Oak ties, 60-lb. rails and Weber joint bars were used, also spring frogs and split switches in all turnouts. All bridges were built to carry a full train of 100,000 lbs. capacity freight cars. Concrete arches and sewer pipe were used in small waterways, and steel and timber structures over the larger.

The trolley wire was carried on span wires, between poles in the usual manner. This gives flexibility to the system, which is a desirable feature; but owing to the limited space in which to place the poles, the author is of the opinion that a bracket system with the trolley wire held to the bracket by means of suitably arranged springs would be preferable.

The author believes that the present general manner of building electric interurban lines is doomed to a speedy change. The idea that these lines are street railways, always to run at low speed, primarily passenger lines, carrying a little baggage and light freight occasionally, will be materially changed at no distant day. Electric roads will be constructed on economical lines, running trains in place of cars, as many freight trains as passenger, and at a speed approaching that of steam trains. There will still be a demand for the slow car along or near the highyways, but those lines which will pay most on capital invested will be those of the best construction.

DISCUSSION.

MR. A. L. KUEHN: The question of the building of electric railways is a highly important one to the State of Illinois, because a number of projects all over the State are now beginning to assume a definite form. The field is new in this State, and because it has proved very successful in other districts there is the semblance of a boom which is much of the same nature as that accompanying the building of the first steam railroads. A great many unworthy projects are being attempted; therefore it is well for us to keep before us the conditions under which an electric railroad can operate.

It is certain that the heavy traffic carried by the great railroads can not yet be carried cheaper by means of electricity, and there are no definite signs as yet that this will be the case very soon. In spite of all said to the contrary, the field of the electric railway lies in the handling of lighter traffic. The fact that electric railways are now operating on a paying basis is not caused by their being operated cheaper than the steam road which they may be paralleling, but by their being operated in a different manner. It is possible to break up a train equipped electrically into small units much more easily than one handled by steam. Therefore it is possible to have small trains at frequent intervals on the electric road much more easily than on the steam road. Trains run at frequent intervals produce increased traffic; and because traffic is increased, rates can be lower, which of itself will also increase traffic. To this the electric railway owes its supremacy over the steam road. From this principle it will also be seen that the primary traffic of the electric railway is passenger traffic; for this is the only traffic that will be influenced by the frequency of trains. Therefore an electric railway will generally not be a sound project unless it is placed so that it will be possible to deal with a comparatively large passenger traffic. Other traffic will naturally come to the road which may produce considerable revenue; but the passenger traffic will be the main dependence, except in special cases. So well is this principle recognized by successful managers, that they spend great energy to produce some attractive place or pleasure ground within easy distance of the larger cities in order to produce travel.

There is a general opinion among some that the roadway of an electric railway can be of cheap and light construction. This is a great error, for the construction should, in general, be fully equal to that of the better class of railroad construction.

As was said, there seems to be a boom in electric railroads at present. This is very dangerous, for as soon as there is a reaction, and the present prosperity drops off, electric railways will be among the first to feel it. Their traffic is of that kind which varies greatly with the condition of the people. A great deal of it can, when necessary, be dispensed with, and any undertaking which is at all unsound will surely suffer and go under.

MR. J. M. MCNABB: The speaker received a surprise in the matter of electric railways last December. He was in Ohio and saw the system of electric railways operating there. This very nearly covers the state, and it is a serious question to the steam roads as to how they are going to retain their local passenger traffic. Traveling men take the electric lines paralleling the steam lines and do fifty to seventy-five per cent. more business than they could on the steam lines. One line which runs from Cleveland through Columbus to Cincinnati furnishes a sleeping-car. Of course the conditions in Ohio are very favorable to electric railways; there are a large number of comparatively large cities quite close to each other.

PROF. A. N. TALBOT: A gentleman who is interested in these interurban railways, and who is building several lines in Indiana and Ohio, told the speaker recently that the difficulty in the way of the construction of the interurban electric railways in this State lies principally in the fact that the companies can not obtain a franchise through incorporated towns for a period exceeding twenty years. In Indiana and other states they may obtain perpetual franchises. This did not at first seem to the speaker to be a strong point; but when it is considered that companies are buying their right-of-way, and not merely running along highways, it may seem to be true.

RECORDS OF THE MAINTENANCE OF WAY DEPARTMENT OF THE RIO GRANDE, SIERRA MADRE & PACIFIC RAILWAY.

BY L. P. ATWOOD.

The following is a description of the methods of keeping office records in the Maintenance of Way Department of the Rio Grande, Sierra Madre & Pacific Railway:

This road is of one division of 250 kilometers or about 156 miles in length. As Engineer of Maintenance of Way, the author has charge of tracks, bridges, and buildings, and their appurtenances. The operating force subordinate to this office at present consists of one bridge gang, made up of a foreman and five laborers; twenty-two section foremen, with generally one laborer each, but aggregating just now twenty-eight laborers for twenty-two sections; and an extra foreman for special work. These are all Mexicans excepting the bridge foreman. Native carpenters are generally employed to do any building repairs needed.

All foremen are required to send their time books to the office by the last train of each month. The pay rolls are made up from these books after checking them over and entering necessary deductions. For a record of the distribution of the labor an ordinary day book of 300 pages is used. For each month two pages are ordinarily required. The left-hand page is ruled into vertical columns each marked at the top to show the different kinds, or classes, of work done during the month. For instance, column (1) is usually "track repairs," including all ordinary work of a section gang; (2) is "switch repairs"; (3) "tie renewals," etc. If one page should not be enough, two would be used. Each gang is given one line, and its time in dollars and cents is entered in the proper column, and the total pay roll of the gang entered in the last column. This is done direct from the time books, and on completion the footing of the last column is checked against the pay roll footings. Each column is then marked at the bottom with the number of the account on the Auditor's general distribution sheet to which the labor is chargeable. A summary of these accounts is then made on the opposite page, together with a detailed record of all new or special work. From this page the distribution sheet and the extraordinary disbursement sheet are filled out, which together with the pay rolls are forwarded to the Auditor's office. There should never be any need to go back of the distribution book for information as to past labor performed.

Each man on the rolls is furnished with a boleta giving his name, station, amount earned, deductions, and amount due for presentation at the pay car. A material statement is made up from carpenters' job slips, and from memoranda made during the month, which is sent to the storekeeper, who is the Master Mechanic. This statement does not include material bought for specific and immediate use. When bills for this latter are approved, they are marked so as to show the work for which it was required, the account number to which it is chargeable, and are then sent to the storekeeper. Neither does it include supplies, tools and material covered by stub requisitions which are handled by the storekeeper. Time books and job slips are filed away for a year and then destroyed.

The Bridge Construction Book is ruled into vertical columns, headed with all sizes and dimensions of material—both lumber and iron—used in the bridges, each bridge occupying a line on the page. This gives concisely, in detail, the material in the structure. Farther on in the same book are recorded the details covering each structure, bent by bent, both pile and frame. Thus far all removals have been recorded alongside corresponding construction record, giving cause of renewal and all data necessary to keep complete records.

Tie renewal records are kept in a 200-page day book. Each kilometer occupies one-half page, and at the end a summary of total renewals for each month is made, as well as a summary for each section for each month. This book will last for many years. This covers all labor and material records, and is kept solely for purposes of record.

In doing work, and for compilation purposes, two ordinary field books are kept in use. One is marked "Engineering Notes and Surveys," containing notes of the staking out of buildings, tanks, turnouts, cross-sections for ditching, grading, etc. The other is marked "Road Book," and contains road inventories, track material used or transferred, etc. A third book is kept in the desk and seldom leaves the office. In it are posted all items of material and labor used in the construction and renewals of all structures pertaining to the Building Department.

When a foreman discharges an employe he issues a time certificate which should have been printed in Spanish. This is exchanged for a stub time check in this office, and the latter can be cashed by the nearest agent, The time certificates are usually kept on file only three months. Stock accident reports are made out by foremen. A duplicate is made and filed in this office, and the original is forwarded to the General Manager's office. Hospital Permits are addressed to nearest company surgeon and a duplicate is kept on file. These last blanks are not issued to foremen.

A form for track material reports was made up at the beginning of operation when we expected to use American foremen; but afterwards it was found impracticable to get native foremen to comprehend it, and as the division was short and work light much of the data is kept in the "Road Notes" Book.

The form given below is a vest pocket record of the curvature, alignment, and gradients of the division. The book is two and a half inches by five inches. For curves and gradients four pages are used, the edge of the middle leaf containing pages 2 and 3 being cut off for the width of column (1):

CURVES.

No.	Between		P. C.	P. T.	Length	D.	L.	R. or L.	Gage Widened	Spiral	Super-elev.	Remarks
	Kilo.	Kilo.										

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GRADIENTS.

No.	Between		Sta.	Sta.	Gradient + or −	Length	Elev.	Elev.	Remarks
	Kilo.	Kilo.							

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TANGENTS.

Between Curves	Course (Magnetic)	Length	Kilo.	Kilo.	Remarks

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The following questions might be pertinent to this subject:

1. In the distribution of each month's labor of the track and bridge forces, is the classification made under more heads, and recorded in your office than is required in your report to the general office?

2. If so, under what heads do you enter such labor for future reference in your office?

3. In what manner do you keep such information?

4. For what length of time do you keep foremen's time books, job slips, stock reports, etc., after you have utilized their data in your reports and statements to your superior officers?

In reference to maintenance of way records the author hardly knows if he can suggest any methods to be followed in all cases, as conditions probably vary in different offices, both as to the extent of work subordinate to that office and data which it is necessary to send to superior officers. In all cases blanks and forms should be of such a size as to fold to one uniform size for convenience in handling and filing. A uniform classification of all routine track and maintenance work would be proper for purposes of comparison; but such a subdivision of accounts could only be maintained, perhaps, when the work was heavy enough to demand a clerk for the office of Maintenance of-Way, or Supervisor's office, as the case might be. The author would like to know of the different bridge inspection blanks and forms; we have only trestles and have no such forms.

THE SHRINKAGE OF EARTH EMBANKMENTS.

DISCUSSION.

MR. A. L. KUEHN: The question of the shrinkage of earth embankments has been given considerable attention recently. From the discussion it is seen that the ordinary shrinkage of earthwork is nowhere near that stated in text books on the subject. However, it has not been emphasized that the shrinkage is dependent upon the manner of constructing the work. The amounts stated in the text books—fifteen to twenty per cent—may be reached if the earth is thrown in loosely; but for embankments made in the ordinary way with scrapers or wagons, the shrinkage will not be more than three or four per cent, because the teaming on the bank while the filling is going on will compress the material. This amount, of course, will vary somewhat with the material.

A good way of making provision for shrinkage is in use on the heavy work in the reconstruction of the Union Pacific Railroad. The slope stakes are set to the proper distance out and the fill is carried to the grade shown by the profile, but the top width of the bank is made such that when it shrinks to its final dimensions there will be room enough to put on top additional material with proper slopes to make up the shrinkage.

MR. H. G. PADDOCK: The speaker has had considerable experience with earth embankments in connection with making sidewalk grades in Moline. The embankments were from one to five feet high; the top widths were about eight feet, or as was sometimes the case, the whole lot was filled in. The material was clay mixed with loam as a rule, but some was a gravelly clay. The embankments were made by teams that worked on the bank in making the fill. Some careful measurements made later showed that there was no perceptible shrinkage. The material was taken from adjacent cuts, and here it was found that the newly cut surfaces had settled considerably.

See also discussion under head of "Trench Filling."

WHAT IS THE BEST METHOD OF PROTECTING EARTH EMBANKMENT SLOPES?

DISCUSSION.

MR. A. L. KUEHN: In order to properly protect embankment slopes some kind of vegetation must be placed upon them; some kind of heavy grass is best. In this connection it might be said that sodding railway banks not only reduces the cost of maintenance but adds materially to their appearance, and since much attention is being paid to appearances by the better class of railroads, this is an important point.

MR. E. E. R. TRATMAN: It may be interesting to know, in connection with the question of sodding railway banks, that on the Chicago, Burlington & Quincy Railroad work in Iowa there are some high embankments which have a top width of forty to fifty feet simply to allow for the washing off of the material by rains. An enormous amount of material must be handled which would not be needed if the banks were sodded.

PROF. A. N. TALBOT: In some parts of the South embankments are covered with a weed or grass which the speaker thinks is called quack grass. It has thick roots which extend into the soil for some distance and mat up, so that the embankment is well protected from washing. Of course this would not do for sand; in fact, the speaker does not know how sand, such as he has seen in some places, could be protected. In Mexico he has seen it drift across the track so that trains were delayed, and in other places he has seen it blown from under the ties.

MR. H. G. PADDOCK: The speaker has seen a sand blow-out arrested by a growth of sand burrs. The sand burr will grow almost anywhere.

REPORT OF THE COMMITTEE ON RAILWAYS.

During the year 1901 the amount of new railway construction in the United States was about 5,000 miles, or a little more than in 1900. The figures as to the new road built in this State during the year are somewhat confusing, one authority giving 80 and another 160 miles as the total. At any rate, the amount of new road built is not very great, but work for permanent improvements has been carried on by nearly all the important existing roads. In view of the International Exhibition to be held at St. Louis in 1903 (or perhaps 1904), it is probable that additional work will be done on the lines centering at that point in order to provide for the expected heavy traffic. Some notes as to the permanent improvement work done during the past year are given below.

PERMANENT IMPROVEMENTS ON ILLINOIS RAILWAYS.

Atchison, Topeka & Santa Fe Railway. The principal work done in this State during the past year has consisted in replacing trestles with permanent work. According to a statement prepared by Mr. W. B. Storey, the Chief Engineer, 1,868 feet of trestle bridges were thus replaced, as follows:

	Lineal Feet.
Trestle replaced by girders on masonry	681
Trestle replaced by arch culverts	595
Trestle replaced by cast-iron pipe	83
Trestle filled and abandoned	409
Total	1,868

Baltimore & Ohio Southwestern Railway. This road has been making extensive improvements and grade reductions upon its line. At the terminals at East St. Louis, Ill., new freighthouses have been built with six tracks and five island platforms between them; the inbound house is 602 feet long and 80 feet wide; and the outbound house 602 feet long and 30 feet wide.

Chicago & Alton Railway. The improvement work on the main line between Chicago and Bloomington is still in progress. New water and coaling stations are being installed, and in some places, as at Carlinville, dams will be built to form reservoirs for water supply. The use of treated timber for bridge floors is being introduced.

Chicago, Burlington & Quincy Railroad. This road has not done much work in Illinois during the past year, but included in this work are the construction of a new suburban station at Riverside and the installation of a 30-lever interlocking plant at the same place. The information given below was furnished by Mr. W. L. Breckenridge, the Chief Engineer:

The Riverside station consists of a main building, 34 feet by 222 feet, on the south side of the main tracks, and a subway entrance, canopy and waiting-room on the north side. At the ends of the main building are shelters extended in lines of the building, the east shelter covering the entrance to the subway. The platforms are of vitrified brick and cement. The exterior finish of all the buildings is of mottled, fire-flashed, pressed brick, with Bedford stone trimming. The roofs are of red tile. The floors are of marble on hollow tile, supported by I-beams. The wainscot paneling is of quarter-sawed oak. The baggage and express room has a cement floor. The buildings are wired for electric light and piped for gas; they are heated by steam, the boiler room being under the baggage-room. The plumbing is of the most modern style, and all exposed work is nickel plated.

The subway, which enables passengers to pass from side to side without crossing the tracks at grade, is 100 feet long, 6½ feet wide in the clear, and 7½ feet high. It is built of concrete, the top of which is only 14 inches below the base of rail, the concrete roof having four 15-inch I-beams embedded in it under each rail. The ceiling and side walls are lined with hollow tile, on which is laid opalite. The floor is of cement laid on hollow tile.

At Galesburg, Ill., this road has established a reservoir of 277,000,000 gallons capacity, to furnish a water supply for its shops, roundhouses and locomotives. The city water is objectionable on account of the proportion of iron which it carries, and the supply has hitherto been obtained from driven wells and a small reservoir. A new dam was built. It is 700 feet long, 12 feet wide on top, and 40 to 45 feet high, the top being 20 feet higher than that of the old reservoir dam. This dam is of earth, having a brick core wall 3 to 4 feet thick at the bottom and 18 inches at top. This is believed to be a novelty in dam construction. The pumping station contains two 65 HP. boilers, engines, pumps, and a Jewell filter of 500,000 gallons capacity. With the new water supply, it is expected that the locomotive boilers will only have to be washed out about once in six months. With the old supply the boilers of switch engines had to be washed out once or twice a week, while those of road engines had to be washed out every second trip.

Most of the work on this road during the past year has been in Iowa, where extensive realinement and reduction of grades is being carried out. In connection with this work a number of deck plate girder bridges have been erected. One of the largest of these was designed for a high crossing of a stream whose drainage area does not permit the use of masonry. The top of tie is 72 feet above the bed of the creek. The three main spans are 75-ft. deck girders, the tower spans are 30-ft. girders, and the abutment spans are 16-ft. I-beams. One 75-ft. span is across the channel, and the others span the end slopes of the bank, the bank ends of these spans resting on temporary pile foundations. The 16-ft. I-beams are used to avoid the construction of a high parapet or bulkhead wall on a new bank. As soon as the bank has settled to its permanent bearing, a masonry abutment will replace the I-beam span. This end construction is necessary on account of the excessive shrinking in a high bank built from steam-shovel excavation. The weight of this double-track bridge is 915,000 pounds. The pedestals are of concrete on piles, and contain 600 cubic yards of concrete.

Chicago Great Western Railway. The Chief Engineer, Mr. F. R. Coates, writes that this road finished laying 75-lb. rail through Illinois the first of the year 1901, and has done very little work in improvement of alinement or reduction of grades. As to new yards and terminals, the size of the 48th Street yard at Chicago has been increased, but the work was of a comparatively uninteresting nature from an engineering point of view. At Bellwood, where the C. G. W. crosses the Chicago Junction Ry , the interlocking plant was rearranged in the spring of 1901, adding fifteen new levers to the twenty levers already there, in order to change the double track at Chicago Junction Railway to two single main tracks. This will add two cross-overs, two side tracks, and a number of additional signals to be handled by the interlocking. As to new stations, etc., quite an addition has been made to the freight house at Chicago, and the plant is now considered one of the best in the city.

During the past year the road has eliminated about twelve trestles, putting in arch or rail-top culverts and filling in earth banks. A small amount of this work is contemplated for the coming year. As to other work for 1902, it is contemplating grade revisions at Ingalton, Lombard, Stillman Valley, and Thorpe; double track from Oelwein to Stanley, and from Dubuque to Fairground; also new yards at Ingalton.

Elgin, Joliet & Eastern Railway. During the past year this road built 135 miles of double track laid with 80-lb. rails, half the line being ballasted with gravel and the other half with ten inches of slag and a top dressing of four inches of cinders. In addition to this, the general work dated below was done, according to a statement furnished by Mr. R. E. Orr, the Chief Engineer:

Built ten miles of terminal yard at State Line, Hammond, using 60-lb. rails.

Relaid seventeen miles of main line with 80-lb. rails.

Ballasted six miles of main line with gravel and eight miles with cinders.

Replaced 220 feet of trestle with five through-plate girders.

Replaced 223 feet of trestle with eleven deck girders.

Replaced 160 feet of trestle with thirteen stone stock passes.

Installed two electric and one lever interlocking plants.

Extended roundhouse at Waukegan five stalls.

Built five-stall roundhouse at 100th Street and Commercial Ave., South Chicago.

Rebuilt 1200 feet of Calumet River dock.

Planked 40,000 sq. ft. of coal dock at South Chicago.

Chicago Passenger Terminals. During the past year there was an agitation in favor of the establishment of a central union station for Chicago; and an interesting discussion of the matter took place at a meeting of the Western Society of Engineers. The advantages would be many, but there would also be serious disadvantages. The cost would be very great, to say nothing of the additional cost for the provision of the necessary street and viaduct approaches, street and elevated railway connections, etc. The first obstacle is the difficulty of obtaining harmonious and concerted action on the part of the several railways, and this difficulty seems to be insuperable. The fact that the C., R. I. & P. Ry. and L. S. & M. S. Ry. have actually commenced work for the construction of a new terminal passenger station on the site of the old station at Van Buren St. and Pacific Ave., seems to indicate the uselessness of attempting a combination of all the roads. The improvement or reconstruction of the Polk St. and Wells St. terminal stations is talked of from time to time, but no definite action has been taken.

ELECTRIC INTERURBAN RAILWAYS.

The building of electric interurban railways to open up new territory and to parallel existing steam railways goes merrily on. Your committee is inclined to think that there is danger of carrying this to an extreme, with the result that the present boom will be followed by a collapse similar to the periodical depressions which have followed the overbuilding of steam railways. As long as times are flourishing, money is plentiful, and plants are new, the railways spread and prosper; but with fixed charges to meet, and deterioration of plant to be provided for in a time of general depression, it seems likely that many of the projects now before the public will have difficulty in weathering the storm. This is more particularly true of such lines as are of a purely speculative character, often paralleling steam roads or even other electric rosds without regard to traffic conditions, and promoted simply to be sold out to persons who will eventually find that they have bought a gold-brick or a white elephant. The latter is perhaps the better simile, for the electric road involves continual expense for operation and maintenance whether it earns anything or not, and it cannot be simply thrown aside as a dead loss. Of course, there is a field, and a large field, for the electric interurban railway; but it seems wise at this time to call attention to the fact that the electric railway bubble is being blown, and will collapse at some time with more or less disastrous results.

In nearly all these railways, motor cars are used; but the St. Louis and Illinois Suburban Ry., from East St. Louis to Belleville, is reported to operate a coal and freight traffic by means of fifty-ton electric locomotives, each having four motors of 150 HP., and being able to haul twelve loaded freight cars. At present the length of haul is twelve miles, but an extension of seventy miles from Belleville to Carbondale is projected to connect with another electric road known as the Coal Belt Electric Ry.

Chicago & Joliet Electric Railway. The city of Joliet has within the past year been connected with Chicago by the Chicago & Joliet Electric Railway Company, and the following particulars of the road will be of interest as a matter of record. They are taken from an article in the "Engineering News," written by a member of the committee after an examination of the line which was opened on Sept. 25.

The line extends from the Chicago city limits to the Court House at Joliet, a distance of thirty-one miles. At Chicago connection is made with the Archer Ave. line of the Chicago City Ry., but no through cars are run into the city. At Joliet the cars pass over the line of the existing electric railway. A branch is under construction from Summit to the village of Lyons, and an extension to Aurora, Ill., is projected.

The route is partly through an agricultural and quarry country, and partly through a rolling wooded country. Local traffic along the line has developed rapidly, and the hourly service of through cars in both directions, in addition to cars running shorter distances, is much more convenient than that of the steam railway. The cars pass through the main streets of the towns, and thus take up and set down passengers close to their destinations. The speed is as high as twenty-five to thirty miles an hour at times, the maximum speed being forty miles per hour.

The line is largely doubled tracked built on its own right-of-way, but there is some single track alongside of the public road. It parallels the line of the Chicago & Alton Ry. for a part of the distance. The grades and curves are, as a rule, easy, but there are maximum grades of five per cent. 400 feet long, going north and four per cent., 200 feet long, going south. The sharpest curve outside Joliet is one of 150 feet radius near the northern limits of Lockport. The very sharp curves are protected by check rails. There are a few plate-girder bridges, and also some culverts, retaining walls, etc., built of the local limestone. Outside of the towns and villages the track is laid with 70-lb. T-rails of the Am. Soc. C. E. section; 60-lb. 6-in. T-rails are used in Joliet, and 73-lb. 7-in. girder rails in Lockport and Lemont. The 70-lb. rails are laid with broken joints, spliced with six-bolt angle bars, and fitted with 9-inch "Protected" copper bonds under the angle bars. There are fifteen ties to each 30-ft. rail length, and the line is ballasted with broken stone. On the private right-of-way the rails are left exposed, but in the road a paving of limestone screenings is filled in between and outside of the rails. The single track portions of the road are being equipped with automatic electric signals.

The cars are of the double-truck pattern, and each car has two compartments and a toilet-room. Some of the cars have also a baggage compartment. Each car is equipped with the Christensen air-brake and an air-whistle instead of a gong, and there is a liberal supply of electric lamps, including powerful electric headlights. Each car has four electric motors of 40 HP., one on each axle, geared for a speed of forty miles an hour. The cars are 48 feet long and 9 feet wide, and seat fifty passengers. They weigh about twenty-six tons loaded.

Power for operating this railway is furnished from the water power and electric generating plant of the Economy Light & Power Company, at Joliet. This is transmitted to a main station at Joliet, and thence to two sub-stations at Lemont and Summit. The Joliet station has three units, each consisting of an induction motor and a direct-connected, continuous-current generator of 250 K. W. There is also a storage battery of 400 K. W. capacity at hour rate. The induction motor is of 360 HP., designed for a current of 2,200 volts and 85 amperes. The general electric generator delivers a current of 550 volts at no load, or 600 volts at full load. The Summit sub-station has two motor-generator sets similar to the above, and a storage batttery of 300 K. W. capacity. The Lemont sub-station has one motor-generator set similar to the others, and a storage battery of 300 K. W. capacity. The current is delivered at the Joliet station at 3,300 volts, sent out at 15,000 volts to the other sub-stations, and transformed down to 600 volts for the trolley wire. The trolley wire is in general carried by span wires between side poles, but on part of the line center poles with brackets are used.

Aurora, Elgin & Chicago Electric Railway. This road is of a very different class from the Chicago & Joliet line, being a long-distance, high-speed line, built on its own right-of-way, with a double track, and operated on the third-rail system instead of by trolley wires. In Chicago a connection will be made at about 58th

Street with the Garfield Park line of the Metropolitan Electric Elevated Railway, and the new road will run west from that point. Between Elmhurst and Wheaton it will largely parallel the Chicago & North-Western Railway. At Wheaton the line forks, one branch going south to Aurora and the other north to Elgin. The road is being well and substantially built, and is laid with 80-℔. rails. The power-house will be at Batavia.

Rockford & Belvidere Electric Railway. This is a country line of comparatively light construction. It forms an extension of the Rockford city line to Belvidere, Ill., 13½ miles, paralleling the Chicago & North-Western Railway, its right-of-way being adjacent to that of the latter road for about half the distance. As on many interurban electric roads, the location was governed largely by right-of-way considerations. The maximum grades are 2 per cent. in the direction of the loaded traffic, and 3 per cent. in the opposite direction. Freight will be carried and a large milk business is expected. The sharpest curves are of 200 feet radius. There are five plate girder bridges, and several small openings spanned by I-beams. The road is single-track, laid with 60-℔. T-rails, 30 feet long, spliced with Weber joints. It has double pole lines, with span wires supporting the trolley wires. Power is furnished by the Rockford Edison Co. Mr. C. C. Stowell, Past President of this Society, was the engineer.

ENGINEERING EDUCATION AND THE PROFESSION OF ENGINEERING.

A few years ago your Committee took up for consideration in its report the question of education in the technical schools, and we again report on this subject, with particular reference to the University of Illinois.

In no profession are the relations so intimate and cordial between the schools that teach the elements and lay the foundations for future success and the men in practice, as in the profession of engineering. No young man is now thought to be fully equipped to enter any of the different branches of the engineering profession until after he has completed a course in some one of our high grade technical schools.

The foundations laid in college must be laid wide and deep if the future engineer expects to make the most of the opportunities that will come to him if he is prepared for them. The engineer in practice who has failed to obtain adequate preparation has little time, and often less inclination, to take up mathematical problems on his own account; and he must confine his work to narrow limits where his practical knowledge will make partial amends for his lack of preparation. The chief aim of an engineering college course should be to prepare the student to enter the profession of engineering, just as the secondary school prepares the student to enter college; in other words, fit him for the study of engineering. The college course should therefore contain the fundamental mathematical and technical subjects to develop the reasoning power of the student and to give him a grasp of his profession, together with a number of general culture subjects that will develop the artistic side of his nature and make him broad and versatile. Theoretical subjects should be illustrated by practice whenever possible, but care must be used to avoid the teaching of manual dexterity at the expense of theoretical training.

The college graduate is not a full-fledged engineer, but is prepared to enter the ranks and work up. His training enables him to acquire experience accurately, and as a consequence we see many young college-trained men occupying positions that would have required years of experience for untrained men to fill acceptably, if at all.

A well-rounded engineering course must be developed and built up to fit the local conditions and requirements of the profession. The men at the head must be broad gauge men with ability to plan and direct; men that will keep alive to the needs of the profession; they must be leaders and not followers. The technical schools of the East were the first to be developed, and they are still monuments to the ability and judgment of their founders. The conditions in the West and Middle West, with a sparse population, were entirely unlike those in the more conservative East. To supply the place of the endowed technical schools, charging high rates of tuition, the state universities have been developed, and we today in the Middle West have technical schools that are not surpassed. Here students may obtain, at a nominal expense, the advantages heretofore enjoyed only by the rich. The growth and development of these technical schools will be illustrated by taking one of the most prominent ones, the Engineering College of the University of Illinois.

The Engineering College of the University of Illinois contains Departments of Architecture, Architectural Engineering, Civil Engineering, Electrical Engineering, Mechanical Engineering and Municipal and Sanitary Engineering. The instruction in mathematics and general culture subjects is practically the same in all the courses, with the exception of the architectural course, where less work is given in mathematics. The technical instruction in the different courses is designed to best fit the men for their respective branches of the engineering profession.

The attendance of students in the Engineering College has grown from a half-dozen students in 1869 to about 500 in the present year. The attendance in the different departments for the last ten years is given in Table I; and the attendance in the different departments by classes for 1899-00, 1900-01 and 1901-02, is given in Table II. The effect of the financial depression in 1892-95 is shown in the decrease in the number of students in the different departments in 1895 to 1898. The Civil Engineering Department recovered in 1897, the Mechanical Engineering Department in 1898-99, while the students in the Departments of Architecture and Electrical Engineering continued to decrease in numbers until 1900-01. The continued decrease in the number of students in the Electrical Engineering Department has certainly been partly due to the frequent changes in the head of the Department. The decrease in the number of students in the Architectural Department is not easy to explain; however, the fact that the time devoted to mathematics in the course in Architecture was reduced from three to two years at about the time that the Civil Engineering Department began to recover after the financial depression is significant, though it may have had no connection with the point in question. It is also interesting in this connection to note that the mathematical training in the departments has been strengthened about in proportion to the relative gain in the number of students. The Municipal and Sanitary Engineering Course is so nearly like the Civil Engineering Course that the students might well be classed together as Civil Engineering students. Making this classification, we see that the Civil Engineering students lack only one of numbering as many as the Architectural and Electrical Engineering students together.

TABLE I.

ATTENDANCE IN COLLEGE OF ENGINEERING OF THE UNIVERSITY OF ILLINOIS FOR TEN YEARS.

(Exclusive of preparatory students.)

YEAR	1892 '93	1893 '94	1894 '95	1895 '96	1896 '97	1897 '98	1898 '99	1899 '00	1900 '01	1901 '02
DEPARTMENT										
Architecture..........	89	94	88	86	64	62	62	50	64	67
Civil Engineering.....	75	73	73	64	72	77	79	96	126	175
Electrical Engineering .	58	84	91	101	84	89	85	71	91	114
Mechanical Engineering	53	48	66	66	57	49	74	85	124	143
Mun'pal and San. Eng.	1	2	2	3	4	2	7	6	7	5
Total.............	276	301	320	320	281	279	307	308	412	504

TABLE II.

ATTENDANCE IN COLLEGE OF ENGINEERING OF THE UNIVERSITY OF ILLINOIS.

(Exclusive of preparatory students.)

DEPARTMENTS OF THE COLLEGE OF ENGINEERING	YEAR 1899-00							YEAR 1900-01							YEAR 1901-02						
	Specials	Freshmen	Sophomores	Juniors	Seniors	Post-graduates	TOTAL IN DEP'T.	Specials	Freshmen	Sophomores	Juniors	Seniors	Post-graduates	TOTAL IN DEP'T.	Specials	Freshmen	Sophomores	Juniors	Seniors	Post-graduates	TOTAL IN DEP'T.
*Architecture	12	8	7	9	9	5	50	9	17	12	9	11	6	64	0	21	17	13	10	6	67
Civil Engineering	2	33	25	19	10	7	96	7	50	26	25	15	3	126	10	62	52	26	22	3	175
Electrical Engineering	8	16	19	11	12	5	71	11	40	12	16	8	4	91	4	58	33	9	6	4	114
‡Mechanical Engineering	5	24	19	17	11	9	85	17	40	20	19	14	14	124	6	47	38	18	20	14	143
Municipal and Sanitary Engineering	0	3	1	0	2	0	6	0	1	0	3	1	2	7	0	0	1	1	1	2	5
Total in Different Classes	27	84	71	56	44	26	308	44	148	70	72	49	29	412	20	188	141	67	59	29	504
TOTAL IN COLLEGE OF ENGINEERING	308							412							504						

*Includes students in Architectural Engineering.

‡Includes students in Railway Mechanical Engineering.

The low cost of living, and the nominal fees, make it possible for poor boys to get an education. A census of the engineering students for one year gave percentages having fathers with vocations as follows: Merchants, 29 per cent.; farmers, 23 per cent.; engineers, 8 per cent.; clerks, 8 per cent.; manufacturers, contractors and mechanics, each 5 per cent.; real estate and insurance, 4 per cent.; ministers, 3 per cent.; teachers, 2 per cent.; miscellaneous, 5 per cent.; not given, 3 per cent.

The students after graduating obtain positions, for the most part, in line with their work in college. The greater part accept salaried positions at the start, although quite a number of the Architectural graduates open up offices at once. Civil Engineering graduates seem to obtain positions paying the largest beginning salaries, and usually advance the most rapidly. Graduates of all the departments go into Structural Engineering. Civil Engineering graduates are attracted most to Railway Engineering, although the number going into Structural Engineering is increasing very rapidly. The demand for engineering graduates is so large in all the departments at present that it is impossible to supply the demand. Six to eight years ago the best students only in the graduating classes obtained desirable positions; now all obtain desirable positions without difficulty.

TABLE III.

NUMBER OF GRADUATES IN THE COLLEGE OF ENGINEERING OF THE UNIVERSITY OF ILLINOIS FOR FIVE YEARS, AND THE NUMBER NOW (1902) IN THE PROFESSION.

	1895-6	1896-7	1897-8	1898-9	1899-0
Number in profession	33	41	43	45	38
Number in other vocations	5	4	0	0	1
Total	38	45	43	45	39

The number of graduates from the College of Engineering for each year and the number now employed in the profession for the last five years are shown in Table III. This is an excellent showing and speaks well for the reputation of the University of Illinois and shows the direct connection between financial and industrial progress and the profession of engineering.

In conclusion your Committee wishes to say that it has been successful in obtaining some interesting papers on railway subjects and hopes that this branch of the profession will continue to be well represented in the proceedings of the Society.

E. E. R. TRATMAN,
L. P. ATWOOD,
M. S. KETCHUM.

HOW CAN THE RUSTING OF NAILS AND SPIKES IN EXPOSED PLACES BE CHECKED?

DISCUSSION.

MR. A. L. KUEHN: The government galvanizes nails and spikes exposed to the action of sea water and obtains good results.

MR. J. L. CLARK: It is claimed that a steel nail will rust quicker than one made of iron. What is the reason for this, if it is so?

PROF. A. N. TALBOT: Contractors say that steel will rust quicker than iron. The speaker cannot say why this is so, but it is probably because the iron is softer.

MR. L. K. SHERMAN: The question of the rusting of iron and steel nails was investigated by the Massachusetts Factory Inspectors' Association. Their inspectors came to a very decided conclusion that iron nails were preferable to steel, as far as rusting was concerned.

STEEL FRAME MILL BUILDINGS.

BY MILO S. KETCHUM.

CHAPTER I.

LOADS.

INTRODUCTION. A steel frame mill building consists of a self-supporting steel frame composed of transverse bents firmly braced by means of purlins, girts and diagonal braces; the entire framework being covered with a fireproof covering usually composed wholly or in part of corrugated iron or steel.

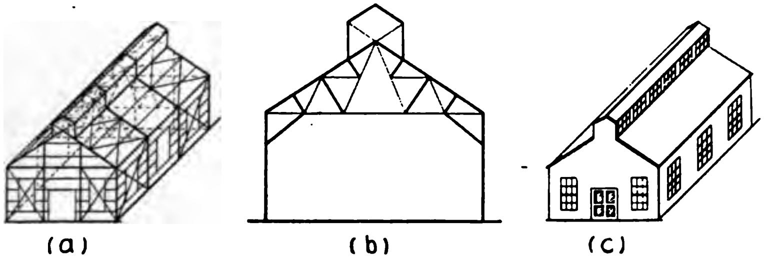
(a) (b) (c)

FIG. 1.

The usual arrangement of the framework is as shown in (a) Fig. 1. An intermediate transverse bent, (b) Fig. 1, consists of a steel roof truss supported at its ends on steel posts which are anchored to the foundations, and is made rigid by knee braces. The end bents are usually made by running the end posts up to the end rafters. If an extension is contemplated a truss bent may

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be used, although the end post bent is equally satisfactory, being simply moved ahead to make the end of the extension.

The building is firmly braced transversely by means of bracing in the planes of the upper and lower chords and the end bents, and by knee braces; and longitudinally by means of bracing in the sides and the planes of the upper and lower chords see (Fig. 13).

The roof covering is supported on steel purlins placed at right angles to the end rafters and upper chords of the trusses. The side covering is fastened to steel girts which are fastened to the side and end posts. Where warmth is desired the sides and roof are lined. The monitor ventilator shown in Fig. 1, is sometimes omitted, one or more circular ventilators being used instead. The glass shown in the sides of the ventilator in (c) Fig. 1, is sometimes replaced by louvres and is sometimes omitted, the space being left entirely open.

Mill buildings are also made (2) by supporting the roof trusses on brick, stone or concrete walls, and (3) by filling in the spaces between the columns of a steel frame mill building with a light brick, stone or concrete wall. When the latter type of building is used the bracing in the walls is usually omitted. The discussion of the steel frame mill building will include practically all the problems and details arising in the design of mill buildings with masonry walls or with masonry filled walls. Types (2) and (3) are often chosen in preference to the steel frame mill building on account of the supposed difficulty in heating the latter.

TYPES OF BUILDINGS. The mill building shown in Fig. 1 is the simplest form and would be used for smelters, boiler houses, engine houses, machine shops and for similar uses. There are many types and forms used for different purposes; however, the discussion of the simple form will include most of the details and problems arising in the complicated forms.

LOADS. The loads to be provided for in designing a mill building will depend to a large degree upon the use to which the finished structure is to be put. The loads may be classed under

(1) dead loads; (2) snow loads; (3) wind loads; (4) miscellaneous loads. Concentrated floor and roof loads, girder and gib crane, and miscellaneous loads should receive special attention, and proper provision should be made in each case. No general solution can be given for providing for miscellaneous loads, but each problem must be worked out to suit local conditions.

DEAD LOADS. Dead loads may be divided into (a) weight of structure; (b) concentrated loads.

The weight of the structure may be divided into (1) the weight of the roof trusses; (2) the weight of the roof covering; (3) the weight of the purlins and bracing; (4) the weight of the side and end walls. The first three items, together with the concentrated roof loads, constitute the dead loads used in designing the trusses.

The weight of a mill building varies so much that it is not possible to give anything more than approximate values for the different items which go to make up the dead load. The following data will, however, materially assist the designer in arriving at approximately the proper dead load to assume for computing stresses, and the approximate weight of metal to use as a basis for preliminary estimates.

Weight of roof trusses. The weight of roof trusses varies with the span, the distance between trusses, the load carried or capacity of the truss, and the pitch.

The empirical formula,

$$W = \frac{P}{45} A\, L \left(1 + \frac{L}{5\sqrt{A}}\right) \tag{1}$$

where

W=weight of steel roof truss in pounds

P=capacity of truss in pounds per sq. feet of horizontal projection of roof (30 to 60 lbs.)

A=distance center to center of trusses (8 to 24 feet)

L=span of truss in feet

was deduced by the writer from the computed and shipping weights of trusses without ventilators. The trusses were riveted fink trusses with purlins placed at panel points, and were made up of angles with connecting plates; minimum size of angles 2″ x 2″ x ¼″, minimum thickness of plates ¼″.

The trusses whose weights were used in deducing this formula had a pitch of ¼ (6″ in 12″), but the formula gives quite accurate results for trusses having a pitch of ⅕ or ⅓. The trusses were designed for a tensile stress of *15000* lbs. per square

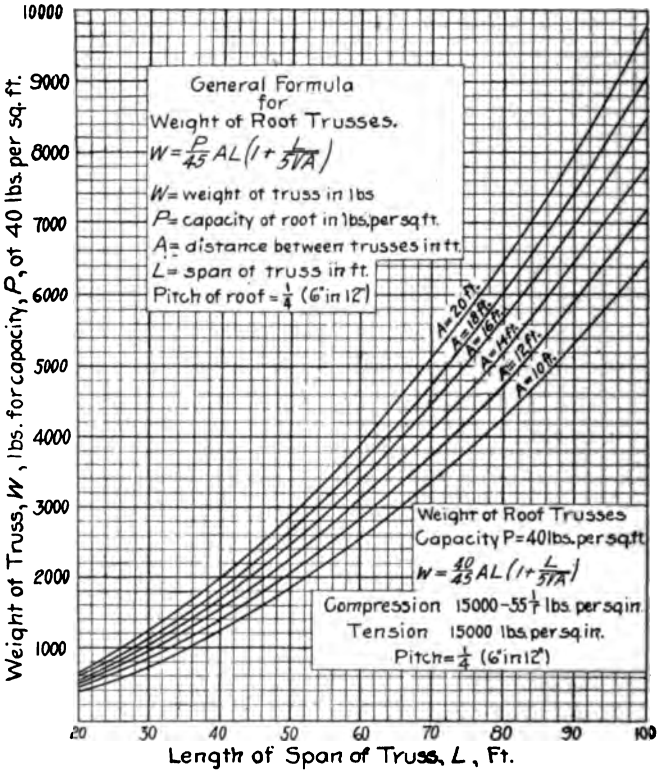


FIG. 2. WEIGHT OF ROOF TRUSSES FOR A CAPACITY OF 40 LBS. PER SQUARE FOOT.

inch and a compressive stress of $15000-55\frac{l}{r}$ lbs. per square inch, where $l =$ length and $r =$ the radius of gyration of the member, both in inches.

The weights of steel roof trusses for a capacity, P, of 40 lbs. per sq. ft. for different spacings is given in Fig. 2. The weights of trusses for other capacities can be obtained by multiplying the tabular values by the ratio of the capacities.

Dividing (1) by $A\ L$ we have the weight of roof truss, W_s, per sq. ft. of horizontal projection of the roof.

$$W_s = \frac{P}{45}\left(1 + \frac{L}{5\sqrt{A}}\right) \tag{2}$$

The weights of steel roof trusses per square foot of horizontal projection of roof for a capacity, P, of 40 lbs. per sq. ft. is given in Fig. 3.

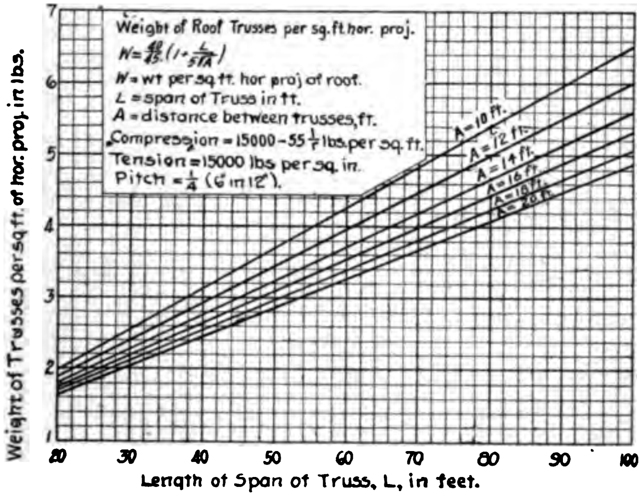


FIG. 3. WEIGHT OF ROOF TRUSSES PER SQUARE FOOT OF HORIZONTAL PROJECTION FOR A CAPACITY OF 40 LBS. PER SQUARE FOOT.

Weight of purlins, girts, bracing and columns. Steel purlins will weigh from 1½ to 4 pounds per square foot of area covered, depending upon the spacing and the capacity of the trusses, and the snow load. If possible the actual weight of the purlins should be calculated. Girts and window framing will weigh from 2 to 5 lbs. per square foot of net surface. Bracing is quite a variable quantity. The bracing in the planes of the upper and lower chords will vary from ¼ to ½ pound per square foot of area. The side and end bracing, eave struts and columns will weigh about the same per square foot of surface as the trusses.

Weight of Covering. The weight of corrugated iron or steel covering varies from 1½ to 3 pounds per square foot of area (see Fig. 19). In estimating the weight of corrugated steel allow about 25 per cent for laps where two corrugations side lap and 6 inches end lap are required, and about 15 per cent for laps where one corrugation side lap and 4 inches end lap are required. Nos. 20 and 22 corrugated steel are commonly used on the roof and Nos. 22 and 24 on the sides. Slate, without sheathing, 3-16 to ¼ of an inch thick weighs from 7 to 9 lbs. per square foot, and terra cotta tile, without sheathing, weighs from 8 to 10 lbs. per square foot. Pine sheathing, where used, should be figured at 3 pounds per foot B. M.

Weight of Structure. The weight of the roof can now be found. A very close approximation to the weight of the steel in the entire structure, where no sheathing is used and the same weight of corrugated iron is used on sides as on roofs, may be found as follows: Take the sum of the horizontal projection of the roof and the net surface of the sides and ends, after subtracting one-half of the area of the windows, wooden doors and clear openings; multiply the sum of these areas by the weight per square foot of the horizontal projection of the roof, and the product will be the approximate weight of the steel in the structure.

SNOW LOADS. The annual snowfall in different localities is a function of the humidity and the latitude and is quite a variable quantity. The amount on the ground at one time is still more variable; in the Lake Superior regions very little of the snow melts, and almost the entire annual snowfall is frequently on the ground at one time; while on the other hand in the same latitude in the Rocky Mountains the dry winds evaporate the snow in even the coldest weather and a less proportion accumulates. In latitudes of 35 to 45 degrees the heavy snowfalls are often followed by a sleeting rain, and the snow and ice load on roofs sometimes nearly equals the weight of the annual snowfall.

From the records of the snowfall for the past ten years as given in the reports of the U. S. Weather Bureau and data obtained by the writer by personal experience, in British Columbia, Montana, the Lake Superior region and central Illinois the writer presents the values given in Fig. 4 for snow loads for roofs of different inclinations in different latitudes. For the Pacific coast and localities with low humidity, take one-half of the values given. The weight of newly fallen snow was taken at 5 lbs. and packed snow at 12 lbs. per cubic foot.

A high wind may follow a heavy sleet and in designing the trusses the writer would recommend the use of a minimum snow and ice load as given in Fig. 4 for all slopes of roofs. The maxi-

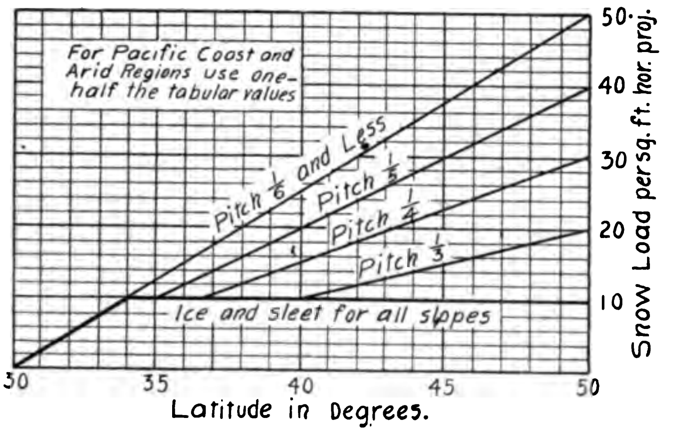


FIG. 4. SNOW LOAD ON ROOFS FOR DIFFERENT LATITUDES, IN LBS. PER SQUARE FOOT.

mum stresses due to the sum of this snow load, the dead and wind loads; the dead and the wind loads; or of the maximum snow load and the dead load being used in designing the members.

WIND LOAD. The wind pressure normal to the direction of the wind (P) in pounds per square foot on a flat surface for any given wind velocity (V) in miles per hour is given quite accurately by the formula

$$P = .0004 \, V^2 \tag{3}$$

The pressure on other surfaces may be taken as follows: 80 per cen ton a rectangular building; 60 per cent on the convex side of cylinders; 115 to 130 per cent on the concave side of cylinders, channels and flat cups; and 130 to 170 per cent on the concave side of spheres and deep cups.

The pressure on buildings normal to the direction of the wind is usually taken as 30 pounds per square foot, equivalent to P equals 37½ pounds in formula (3). This would give a velocity of the wind of 96 miles per hour, which would seem to be sufficient for all except the most exposed positions. The records of the U. S. Weather Bureau for the last ten years show only one instance of where the wind pressure as recorded by the anemometer was more than 90 miles per hour. The wind is usually considered as acting horizontally.

The normal component of the wind pressure on an inclined surface has usually been computed by Hutton's empirical formula

$$P_n = P \, Sin \, A^{\, 1.842 \, Cos \, A - 1} \tag{4}$$

where P_n equals the normal component of the wind pressure, P equals the pressure per square foot on a vertical surface, and A equals the angle of the inclination of the surface with the horizontal.

The formula due to Duchemin

$$P_n = P \, \frac{2 \, Sin \, A}{1 + Sin^2 \, A} \tag{5}$$

where P_n, P and A are the same as in (4), gives results considerably larger for ordinary roofs than Hutton's formula, and is coming into quite general use.

The formula

$$P_n = \frac{P}{45} A \qquad (6)$$

where P_n and P are the same as in (4) and (5), and A is the angle of inclination of the surface in degrees (A being equal to or less than 45°), gives results which agree very closely with Hutton's formula.

The values of P_n as obtained by Hutton's, Duchemin's and the Straight Line formulas are given in Fig. 5, for P equals 20, 30 and 40 pounds.

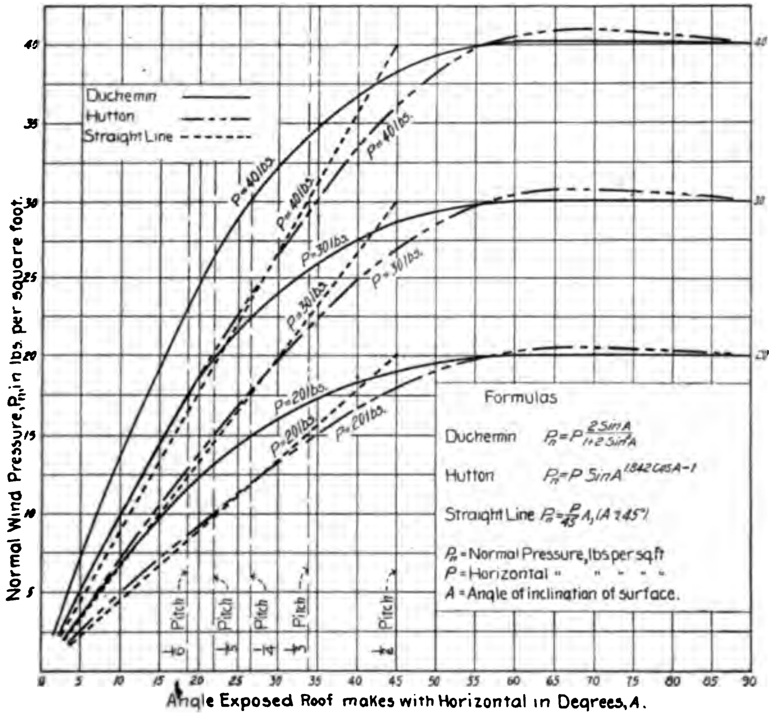


FIG. 5. NORMAL WIND LOAD ON ROOF ACCORDING TO DIFFERENT FORMULAS.

It is interesting to note that Duchemin's formula with P equals 30 pounds gives practically the same values for roofs of ordinary inclination as is given by Hutton's formula with P equals 40 pounds.

Duchemin has also deduced the formula

$$P_h = P \frac{2 \, Sin^2 \, A}{1 + Sin^2 \, A} \qquad (7)$$

where P_h in (7) equals the pressure parallel to the direction of the wind; and

$$P_l = P \frac{2 \, Sin \, A \, Cos \, A}{1 + Sin^2 \, A} \qquad (8)$$

where P_l in (8) equals the pressure at right angles to the direction of the wind. P_l may be an uplifting, a depressing, or a side pressure. With an open shed in exposed positions the uplifting effect of the wind often requires attention. In that case the wind should be taken normal to the inner surface of the building on the leeward side, and the uplifting force determined by using formula (8).

If the gables are closed a deep cup is formed, and the normal pressure should be increased 30 to 70 per cent. That the uplifting force of the wind is often considerable in exposed localities is made evident by the fact that highway bridges are occasionally wrecked by the wind. The most interesting example known to the writer is that of a 100-foot span combination bridge in Northwestern Montana which was picked up bodily by the wind, turned about 90 degrees in azimuth, and dropped into the middle of the river. The end bolsters were torn loose although drift-bolted to the abutments.

The wind pressure is not a steady pressure, but varies in intensity, thus causing excessive vibrations which cause the structure to rock if the bracing is not rigid. The bracing in mill buildings should be designed for initial tension, so that the building will be rigid. Rigidity is of more importance than strength in mill buildings.

CHAPTER II.

CALCULATION OF STRESSES.

INTRODUCTION. The stresses in the framework of a mill building are due to (1) the dead load; (2) the snow load; (3) the wind load; and (4) concentrated and moving loads. The stresses due to dead, snow and wind loads in a transverse bent will be taken up and discussed in the order given. The stresses in the bracing are principally due to wind loads. The effect of concentrated and moving loads will be omitted from the discussion on account of lack of space and diversity of conditions that may occur in practice.

DEAD LOAD STRESSES. The dead load is usually considered as being applied in joint loads at the panel points of the upper chord for computing stresses in the roof truss, and at the top of the columns for designing the columns. If the purlins do not come at the panel points the upper chord will have to be designed for both direct stress and stress due to flexure. The stresses due to the dead load in the trusses of a mill building are the same as if the trusses were supported on solid walls. The stresses in the supporting columns are due to the dead load of the roof and the part of the side walls supported by the columns, and are direct compressive stresses if the columns are not fixed at the top. The dead load produces no stress in the knee braces of a bent of the type shown in (b) Fig. 1 except that due to deflection of the truss, which may be omitted. The stresses may be computed by algebraic or graphical methods. The ordinary algebraic methods are (1) algebraic resolution and (2) algebraic moments. These methods are familiar and will not be discussed further. The most common graphical method is graphical resolution, also called the reciprocal polygon method. This method is illustrated in Fig. 8.

SNOW LOAD STRESSES. Large snow storms nearly always occur in still weather, and the maximum snow load will therefore be a uniformly distributed load. A heavy wind may follow a sleet storm and a snow load equal to the minimum given in Fig. 4 should be considered as acting at the same time as the wind load. The stresses due to snow load are found in the same way as the dead load stresses. In localities having a heavy fall of snow the freezing and thawing often cause icicles to form on the eaves of sufficient weight to tear off the cornice, unless particular care has been exercised in the design of this detail.

WIND LOAD STRESSES. The analysis of the stresses in a bent due to wind loads is similar to the analysis of the stresses in the portal of a bridge. The external wind force is taken (1) as horizontal or (2) as normal to all surfaces. The first is the more common assumption, although the second is more nearly correct. For a comparison of the stresses in a bent due to the wind acting horizontally and normal, see Figs. 9, 10, 11 and 12, and Table I. In the discussion which immediately follows the external wind force will be assumed to act horizontally at a height equal to one-half the height of the structure.

The intensity of the wind stresses in the trusses, knee braces and columns will depend (a) upon whether the base of the columns are fixed or free to turn, (b) upon whether the columns are rigidly fixed to the truss at the top, and (c) upon the knee brace and truss connections. Of the numerous assumptions that might be made, only two, the most probable, will be considered, viz.: (I) columns pin connected (free to turn) at the base and top, and (II) columns fixed at the base and pin connected at the top.

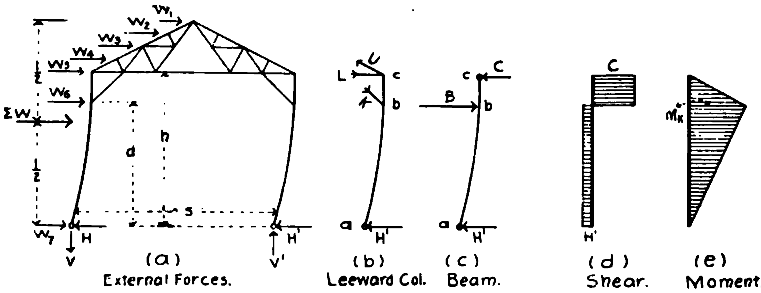
Columns in mill buildings are usually fixed by means of heavy bases and anchor bolts. Where the columns support heavy loads the dead load stress in the columns will assist in fixing them. Where the dead load stress minus the vertical component of the wind stress in the column, multiplied by one-half the width of the base of the column parallel to the direction of the wind, is greater than the bending moment developed at the base of the windward column when the columns are considered as fixed, the columns will be fixed without anchor bolts. In any case the resultant moment is all that will be taken by the anchor bolts. The dead load stresses in mill buildings are seldom sufficient to give material assistance in fixing the columns. Unless great care is used in anchoring columns it is best to design mill buildings for columns hinged at the base.

The general problem of stresses in a transverse bent for Case I and Case II will now be considered, in which the stresses and forces will be determined by algebraic methods. The application of the general problem will be further explained by the graphical solution of a particular problem.

ALGEBRAIC CALCULATION OF STRESSES.

CASE I. COLUMNS FREE TO TURN AT BASE AND TOP.

In Fig. 6, $H = H^1 = \frac{W}{2} =$ horizontal reactions at the base of the columns due to external wind force W.



(a) External Forces. (b) Leeward Col. (c) Beam. (d) Shear. (e) Moment.

FIG. 6.

$V = -V^1 = \frac{W\,l}{2\,s} =$ vertical reaction at base of column due to the wind force W.

The wind produces bending in the columns, and also the direct stresses V and V^1. Maximum bending occurs at the foot of the knee brace and is equal to $(H - W_7)d$ on the windward side, and $H^1 d$ on the leeward side. These bending moments are the same as the bending moments in a simple beam supported at both ends and loaded with a concentrated load at the point of maximum moment. Since the maximum moment occurs at the foot of the knee brace in the leeward column, we will consider only that side. We will assume that the leeward column (b), Fig. 6, acts as a simple beam with reactions H^1 and C and a concentrated load B, as in (c), Fig. 6. The reaction C and load B will now be calculated.

From the fundamental equation of equilibrium, summation horizontal forces equal zero, we have

$$B = H^1 - C \qquad (9)$$

Taking moments about b, we have

$$C\,(h - d) = H^1 d$$

$$C = \frac{H^1 d}{h - d} \qquad (10)$$

The stresses K, U and L can be computed by means of the following formulas:

$$K = B \; cosecant \; m \qquad (11)$$

where m = angle knee brace makes with column

$$U = (V^1 - K \cos m, \; cosecant \; n \qquad (12)$$

where n = angle of pitch of roof

$$L = C - U \cos n \qquad (13)$$

In calculating the corresponding stresses on the windward side, the wind components acting at the points (a), (b) and (c) must be subtracted from H, B and C.

The shear in the leeward column is equal to H^1 below and C above the foot of the knee brace (d), Fig. 6.

The moment in the column is shown in (e), Fig. 6, and is a maximum at the foot of the knee brace and is equal to $H^1 d$.

The maximum fibre stress due to wind moment and direct loading in the columns will occur at the foot of the knee brace in the leeward column, and will be compression on the inside and tension on the outside fibres, and is given by the formula

$$f_2 + f_1 = \frac{P}{A} \pm \frac{My}{I - \frac{Ph^2}{10E}} \qquad (14)$$

where f_1 = maximum fibre stress due to flexure

f_2 = fibre stress due to direct load P

A = area of cross section of column in square inches

M = bending moment in inch pounds = $H^1 d$

y = distance from neutral axis to extreme fibre of column in inches

I = Moment of Inertia of column about an axis at right angles to the direction of the wind

P = direct compression in the column in pounds

h = length of the column in inches

E = the modulus of elasticity of steel = 28,000,000

The maximum compressive wind stress is added to the direct dead and minimum snow load compression and governs the design of the column.

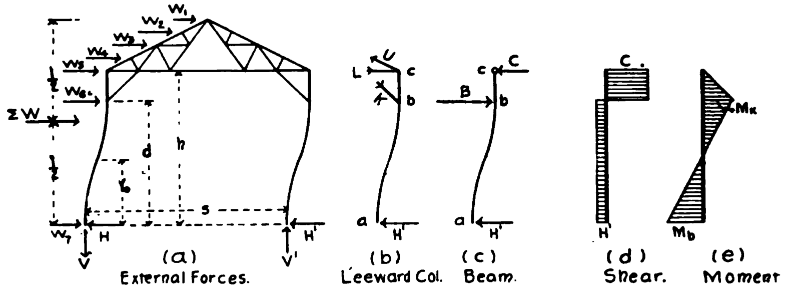
Having the stresses K, U, and L, the remaining stresses in the truss can be obtained by ordinary algebraic or graphical processes.

For a simple graphical solution of the stresses in a bent for Case I, in which these stresses are computed graphically, see Fig. 9 for wind horizontal, and Fig. 11 for wind normal to all surfaces.

CASE II. COLUMNS FIXED AT THE BASE.

With columns fixed at the base the columns may be (1) hinged at the top, or (2) rigidly fixed to the truss.

(*1*) *Columns fixed at the base and hinged at the top.* It will be further assumed that the deflection at the foot of the knee brace and the top of the column, Fig. 7, are equal.



(a) External Forces. (b) Leeward Col. (c) Beam. (d) Shear. (e) Moment

FIG. 7.

In Fig. 7 we have as in Case I

$$H = H^1 = \frac{W}{2}.$$

V and V^1 are not as easily found as in Case I, but will be calculated presently.

The leeward column will be considered and will have horizontal external forces acting on it as shown in (c) Fig. 7. For convenience we will consider the leeward column as a beam fixed at a and acted upon by the horizontal forces B and C as shown in (c) Fig. 7; the deflection of the points b and c being equal by hypothesis.

From the fundamental condition of equilibrium, summation horizontal forces equal zero, we have

$$B = H^1 + C \qquad (15)$$

To obtain B and C a second equation is necessary.

From the theory of flexure we have for the bending moment in the column at any point y, where the origin is taken at the base of the column, when $y \leqq d$

$$M = EI\frac{d^2x}{dy^2} = B(d - y) - C(h - y) \qquad (16)$$

Integrating (16) between the limits $y = 0$ and $y = d$, we have

$$EI\frac{dx}{dy} = \left[Bdy - \frac{By^2}{2} - Chy + \frac{Cy^2}{2} + F\right]_{y=0}^{y=d}$$

$$= -C\left(hd - \frac{d^2}{2}\right) + \frac{Bd^2}{2} \qquad (17)$$

Now (17) equals $E\,I$ times the angular change in the direction of the neutral axis of the column from $y = o$ to $y = d$.

When $y \geqq d$ we have

$$M = E\,I\frac{d^2x}{d\,y^2} = -\,C(h-y) \tag{18}$$

Integrating (18) we have

$$E\,I\frac{d\,x}{d\,y} = -\,C\,h\,y + \frac{C\,y^2}{2} + F_2 \tag{19}$$

Now (19) equals $E\,I$ times the change in direction of the neutral axis of the column at any point from $y = d$ to $y = h$.

To determine the constant F_2 in (19) we have the condition that the angle at $y = d$ must be the same whether determined from equation (17) or equation (19). Equating (17) and (19) and making $y = d$, we have

$$F_2 = \frac{B\,d^2}{2} \tag{20}$$

Substituting this value of F_2 in (19) we have

$$E\,I\frac{d\,x}{d\,y} = -\,C\,h\,y + \frac{C\,y^2}{2} + \frac{B\,d^2}{2} \tag{21}$$

Integrating (21) between the limits $y = d$ and $y = h$, we have

$$\begin{aligned} E\,I\,x &= \left[-\frac{C\,h\,y^2}{2} + \frac{C\,y^3}{6} + \frac{B\,d^2\,y}{2}\right]\begin{matrix} y = h \\ y = d \end{matrix} \\ &= C\left(\frac{h\,d^2}{2} - \frac{d^3}{6} - \frac{h^3}{3}\right) + B\left(\frac{d^2\,h}{2} - \frac{d^3}{2}\right) \end{aligned} \tag{22}$$

Now (22) equals $E\,I$ times the deflection of the column from $y = d$ to $y = h$, which equals zero by hypothesis.

Solving (22) we have

$$\begin{aligned} \frac{C}{B} &= \frac{3\,d^2\,h - 3\,d^3}{-\,3\,h\,d^2 + d^3 + 2\,h^3} \\ &= \frac{3\,d^2}{2\,h^3 + 2\,d\,h - d^2} \end{aligned} \tag{23}$$

In a beam fixed at one end there is a point of inflection at some point between $y = o$ and $y = d$ where the bending moment equals zero. Now if y_o equals the value of y for the point of inflection, we have from (16)

$$B\,(d - y_o) = C\,(h - y_o) \text{ and}$$

$$\frac{C}{B} = \frac{d - y_o}{h - y_o} \qquad (24)$$

Equating the second members of equations (23) and (24) and solving for y_o, we have

$$y_o = \frac{d}{2}\left(\frac{d + 2h}{2d + h}\right) \qquad (25)$$

To find the relations between y_o and d, we will substitute h in terms of d in (25) and solve for y_o.

$$\text{For} \quad d = \frac{h}{2}, \qquad y_o = \frac{5}{8}\,d$$

$$d = \frac{2}{3}\,h, \qquad y_o = \frac{4}{7}\,d$$

$$d = h, \qquad y_o = \frac{1}{2}\,d$$

Solving (15) and (23) for C, we have

$$C = \frac{H^1}{2}\,\frac{3\,d^2}{(h - d)\,(h + 2\,d)} \qquad (26)$$

To find the moment M_b at the base of the leeward column, we have from (16)

$$M_b = B\,d - C\,h$$

Substituting the value of B given in (15) we have

$$M_b = H^1\,d + C\,d - C\,h \qquad (16a)$$

Eliminating h and d by means of (25) and (26) we have finally

$$M_b = H^1\,y_o \qquad (27)$$

In like manner it can be shown that the moment at the base of the windward column is

$$M_{b_1} = H\,y_o - \frac{w\,d^2}{8} \qquad (27a)$$

where w equals the wind load per foot of height.

To find V we will take moments about the leeward column. The moments M_b and M_{b_1} at the bases of the columns respectively, resist overturning and we have

$$V = -V^1 = \frac{1}{s}\left[\frac{w\,l^2}{2} - M_b - M_{b_1}\right]$$

$$= \frac{1}{s}\quad\left[H\,l - 2\,H\,y_o + \frac{w\,d^2}{8}\right] \qquad (28)$$

$$\text{since} \quad H = \frac{w\,l}{2}$$

Now if $\frac{d}{2}$ is taken equal to y_o we have after transposing

$$V = -V^1 = \frac{1}{s}\,[2\,H - w\,y_o]\quad\left[\frac{l - y_o}{2}\right] \qquad (29)$$

It will be seen that (29) is the same value of V and V^1 that we would obtain if the bent were hinged at the point of contraflexure.

From (27) and (29) it will be seen that we can consider the columns as hinged at the point of contraflexure and solve the problem as in Case I, taking into account the wind above the point of contraflexure only. The maximum shear in the column is shown in (d) Fig. 7.

The maximum positive moment occurs at the foot of the leeward knee brace and is $M_k = H\,(d - y_o)$; the maximum negative moment occurs at the base of the leeward column and is equal to $M_b = H\,y_o$.

The maximum compressive stress occurs at either the base of the column or the foot of the knee brace, and is given by the following formula:

$$f_2 + f_1 = \frac{P}{A} \pm \frac{M\,y}{I - \frac{P\,h^2}{24\,E}} \qquad (14a)$$

The nomenclature being the same as for (14) except h which is the distance in inches from the point of contra flexure to the top of the column.

(2) *Columns fixed at the base and top.*

In this case it can be seen by inspection that the point of inflection is at a point $y_o = \frac{d}{2}$ and we have for this case

$$B = H^1 + C \qquad (15a)$$

$$M_b = \frac{H^1\,d}{2} = M_k \qquad (27b)$$

$$C = \frac{H^1 d}{2 (h - d)} \tag{26a}$$

It is difficult to realize the exact conditions in either (1) or (2), in Case II, and it is probable that when an attempt is made to fix columns at the base, the actual conditions lie some place between (1) and (2). It would therefore seem reasonable to assume the minimum value, $y_0 = \frac{d}{2}$ as the best value to use in practice. This assumption is commonly made and will be made in the problems which follow.

Having the external forces H^1, B, C and V^1, the stresses K, U and L are computed by formulas (11), (12) and (13). The remaining stresses in the trusses can then be computed by ordinary algebraic or graphical methods.

For a simple graphical solution of this problem, where the external forces B and C are not computed, see Fig. 10 and Fig. 12.

MAXIMUM STRESSES. It is not probable that the maximum snow and wind loads will ever come on the building at the same time, and it is therefore not necessary to design the structure for the sum of the maximum stresses due to dead load, snow load and wind load. A common method is to combine the dead load stresses with the snow or the wind load stresses which will produce maximum stresses in the members. It is, however, the practice of the writer to consider that a heavy sleet may be on the roof at the time of a heavy wind, and to design the structure for the maximum stresses caused by dead and snow load; dead load, minimum snow load and wind load; or dead load and wind load. It should be noted that the maximum reversals occur when the dead and wind load are acting. For a comparison of the stresses due to the different combinations see Table II.

A common method of computing the stresses in a truss of the fink type for small buildings is to use an equivalent uniform vertical dead load; the knee braces and the members affected directly by the knee braces being designed according to the judgment of the engineer. This method is satisfactory and expeditious when used by an experienced man, but like other short cuts is dangerous when used by an inexperienced man. For a comparison of the stresses in a 60-foot fink truss by the exact and the approximate method above, see Table II.

STRESSES IN END FRAMING. The external wind force on an end bent will be one-half what it would be on an intermediate transverse bent, and the shear in the columns may be taken as equal to the total external wind force divided by the number of columns in the braced panels. The stresses in the diagonal rods in the end framing as in Fig. 13 will then be equal to the external wind force *H*, divided by the number of braced panels, multiplied by the secant of the angle the diagonal rod makes with a vertical line.

BRACING IN THE UPPER CHORD AND SIDES. The intensity of the wind pressure is taken the same on the end as the sides, and the wind loads are applied at the bracing connection points along the end rafters and the corner columns. The shear transferred by each braced panel is equal to the total shear divided by the number of braced panels.

The stresses in the diagonals in each braced panel are computed by applying wind loads at the points above referred to, the wind loads being equal to the total wind loads divided by the number of panels. The stresses are computed as in a cantilever truss.

The bracing in the plane of the lower chord is designed to prevent undue deflection of the end columns and to brace the lower chord of the trusses.

All wind braces should be designed for say 5,000 pounds initial stress in each member, and the struts and connections should be proportioned to take the resulting stresses.

It should be noted that a mill building braced as Fig. 13 could be made rigid without knee braces if the bracing were made sufficiently strong.

GRAPHICAL CALCULATION OF STRESSES.

Data. To illustrate the method of calculating the stresses in a transverse bent by graphical processes, the following data for a transformer building similar to one designed by the writer will be taken.

The building will consist of a rigid steel frame covered with corrugated steel and will have the following dimensions: Length of building, 80′ 0″; width of building, 60′ 0″; height of columns, 20′ 0″; pitch of truss, ¼ (6″ in 12″); total height of building, 35′ 0″; the trusses will be spaced 16′ 0″ center to center. The trusses will be riveted fink trusses. Purlins will be placed at the panel points of the trusses and will be spaced for a normal roof load of 30 lbs. per square foot. The roof covering will consist of No. 20 corrugated steel with 2½-inch corrugations, laid with 6-inch end laps and two corrugations side laps, with anti-condensation lining (see (l) Fig. 19). The side covering will consist of an outside covering of No. 22 corrugated steel with 2½-inch corrugations, laid with 4-inch end laps and one corrugation side lap; and an inside lining of No. 24 corrugated steel with 1¼-inch corrugations, laid with 4-inch end laps and one corrugation side lap. For additional warmth two layers of tar paper will be put inside of the lining. Three 36-inch Star ventilators placed on the ridge of the roof will be used for ventilation. The general arrangement of the framing and bracing will be as in Fig. 13.

The approximate weight of the roof per square foot of horizontal projection will be as follows:

Trusses	3.6 lbs. per sq. ft.
Purlins and Bracing	3.0 lbs. per sq. ft.
Corrugated Steel	2.4 lbs. per sq. ft.
Roof Lining	1.0 lbs. per sq. ft.
Total	10.0 lbs. per sq. ft.

The maximum snow load will be taken at 20 pounds, and the minimum snow load at 10 pounds per square foot of horizontal projection of roof.

The wind will be taken at 20 pounds per square foot on a vertical projection for the sides and ends of the building, and 20 pounds per square foot on a vertical surface when the wind is considered as acting horizontal on the vertical projection of the roof, and 30 pounds per square foot on a vertical surface when the wind is considered as acting normal to the roof.

The stresses in an intermediate transverse bent will be calculated for the following:

CASE 1. Permanent dead and snow loads.

CASE 2. A horizontal wind load of 20 pounds per square foot on the sides and vertical projections of the roof, with the columns hinged at the base.

CASE 3. Same wind load as in Case 2, with columns fixed at the base.

CASE 4. A horizontal wind load of 20 pounds per square foot on the sides, and the normal component of a horizontal wind load of 30 pounds per square foot on the roof, with columns hinged at the base.

CASE 5. Same wind load as in Case 4, with columns fixed at the base.

CASE 1. PERMANENT DEAD AND SNOW LOAD STRESSES.

On account of the limited size of the stress diagram the secondary members have been omitted and the loads applied as shown in Fig. 8. The seven loads producing stresses in the truss are laid off to the prescribed scale, $x_1 — y$ being the left, and $y — x_8$ the right reaction. The stresses are calculated as follows: Beginning with the left reaction $x_1 — y$, draw lines through x_1 and y parallel to the upper and lower chords of the truss respectively, and the lines $x_1 — 2$ and $y — 2$ will represent the compressive stress in the member $x_1 — 2$ and the tensile stress in the member $y — 2$ to the scale of the stress diagram.

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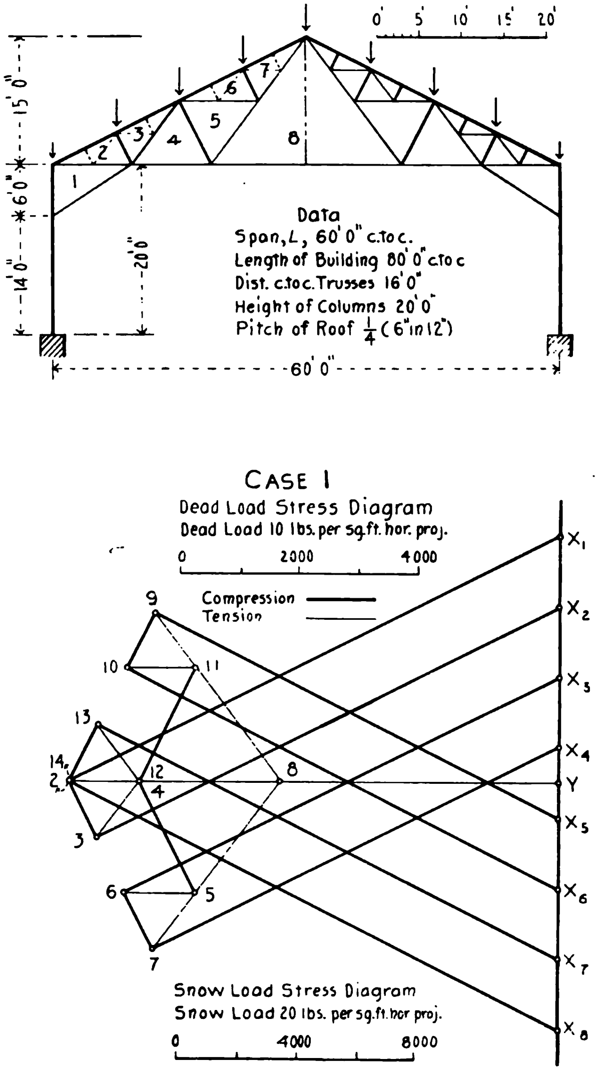


FIG. 8. DEAD AND SNOW LOAD STRESS DIAGRAM.

Calculate the stresses in the remaining members in like manner, being careful to take the members in order around a joint in completing any polygon. The indeterminate case at the middle of the top chord can be most easily solved by calculating the stress in 5–6 and substituting it in the diagram. Compression and tension in the truss and stress diagram in Fig. 8 are indicated by heavy and light lines respectively.

The stress in each column is equal to one-half the sum of the vertical loads plus the load carried directly by the column.

CASE 2. WIND LOAD STRESSES, WIND HORIZONTAL, COLUMNS HINGED.

The wind will be considered as acting at the joints, as shown in Fig. 9. Replace the columns with trusses as indicated by the dotted lines. This makes the bent a two-hinged arch, and the stresses will be statically determinate as soon as the horizontal reactions H and H^1 at the bases of the columns have been determined. The usual assumption in mill buildings and portals of bridges is that $H = H^1 = \frac{W}{2}$ where $W =$ the horizontal component of the external wind force. To calculate V and V^1 produce the line of resultant wind until it intersects a vertical line through the center of the truss, and connect the intersection A with the bases of the columns B and C. From A lay off $H = H^1 = \frac{W,}{2}$ as shown in Fig 9, and complete the triangles by drawing vertical lines through the ends of these lines. The vertical closing lines will be $V = -V^1$, as shown in Fig. 9.

The stresses are calculated as follows: Beginning with the foot of the column B, lay off the dotted line A—B $= R$. At B, lay off the load a—B = 2240 lbs.; through a draw a line parallel to auxiliary truss member a—b, and through A draw a line parallel to the column b—A, completing the polygon A—B—b—a.

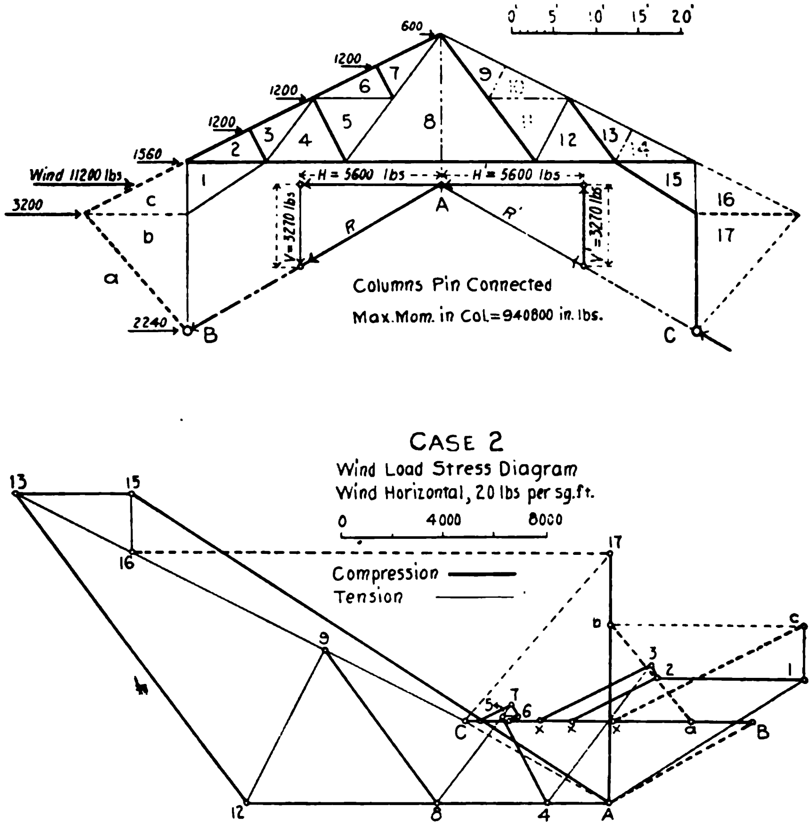


FIG. 9. WIND LOAD STRESS DIAGRAM, CASE 2.

a—b in the stress diagram will be the compression in the auxiliary member a—b, and A—b will be the tension in the column A—b. It should be noted that *V* is equal to the algebraic sum of the vertical components of the stresses in a—b and A—b. Next lay off x—a = 3200 lbs. and complete the polygon a—x—c—b by drawing lines through x and b parallel to the auxiliary truss mem-

bers x—c and b—c respectively. In like manner determine the stresses at the foot of the knee brace by constructing the polygon A—b—c—1; and at the top of the column by constructing the polygon c—x—x—2—1, etc., until the diagram is checked up at C with C—A = R^1. The indeterminate case at the joint 3—4—5 can be most easily solved by computing the stress in 5—6 (component due to stress in 6—7), and substituting it in the diagram. The stresses in the auxiliary members are presented by dotted lines and are of no value in designing the bent. It should be noted that the auxiliary members do not affect the stresses in the trusses and knee braces, which are correctly given in the stress diagram.

The maximum stress in the knee brace A—15 is compression and occurs on the leeward side.

The maximum shear in the leeward column below the knee brace is H^1 = 5600 lbs.; the maximun shear above the knee brace is 13100 lbs. The maximum moment occurs at the foot of the knee brace and is H^1 x 14 x 12 = 940800 inch lbs.

CASE 3. WIND LOAD STRESSES, WIND HORIZONTAL, COLUMNS FIXED AT BASE.

This is Case 2 with the base of the column hinged at the point of contraflexure. In calculating H and V the wind above the point of contraflexure only (see formula [29]) produces stresses in the bent. The value of fixing the columns at the base is seen by comparing the stresses in Case 2 with those in Case 3, both being drawn to the same scale. Maximum shear in the leeward column below the knee brace is H^1 = 4480 lbs.; above the knee brace is 5600 lbs. The maximum positive moment occurs at the foot of the knee brace and negative moment at the foot of the column and is H^1 x 7 x 12 = 376320 inch lbs.

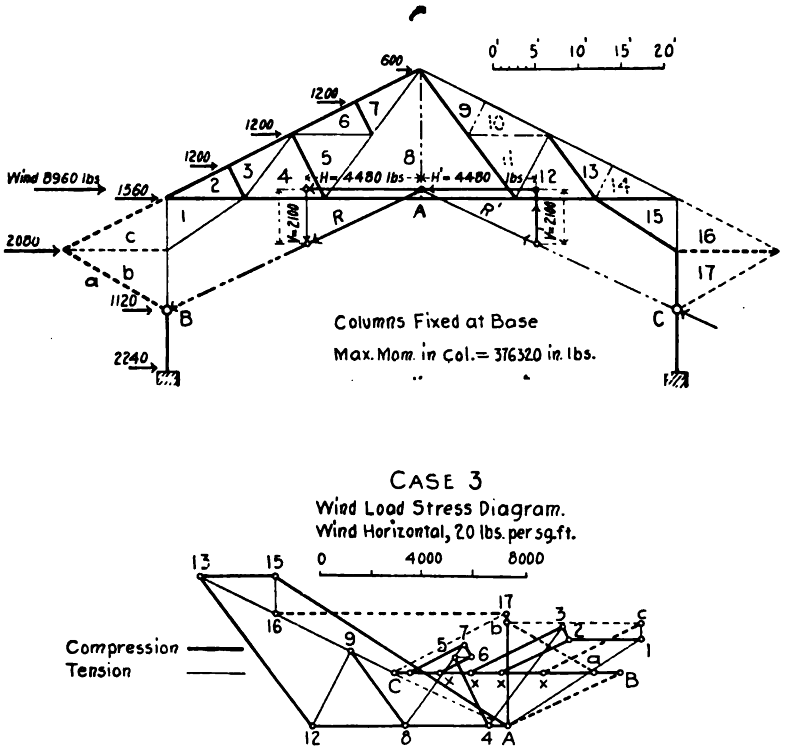


FIG. 10. WIND LOAD STRESS DIAGRAM, CASE 3.

CASE 4. WIND LOAD STRESSES, WIND NORMAL, COLUMNS HINGED.

In Fig. 11 the resultant of the external wind forces on the sides and roof acts through their intersection and is parallel to C B in the stress diagram. To calculate V and V^1 connect the intersection A of the resultant wind and the vertical line through the center of truss with the bases of the columns B and C, and lay off $H = H^1 = 5500$ lbs. with extreme ends on dotted lines A—B and A—C. The vertical lines V and V^1 will be the vertical reactions, and R and R^1 will be the resultant of the horizontal and vertical

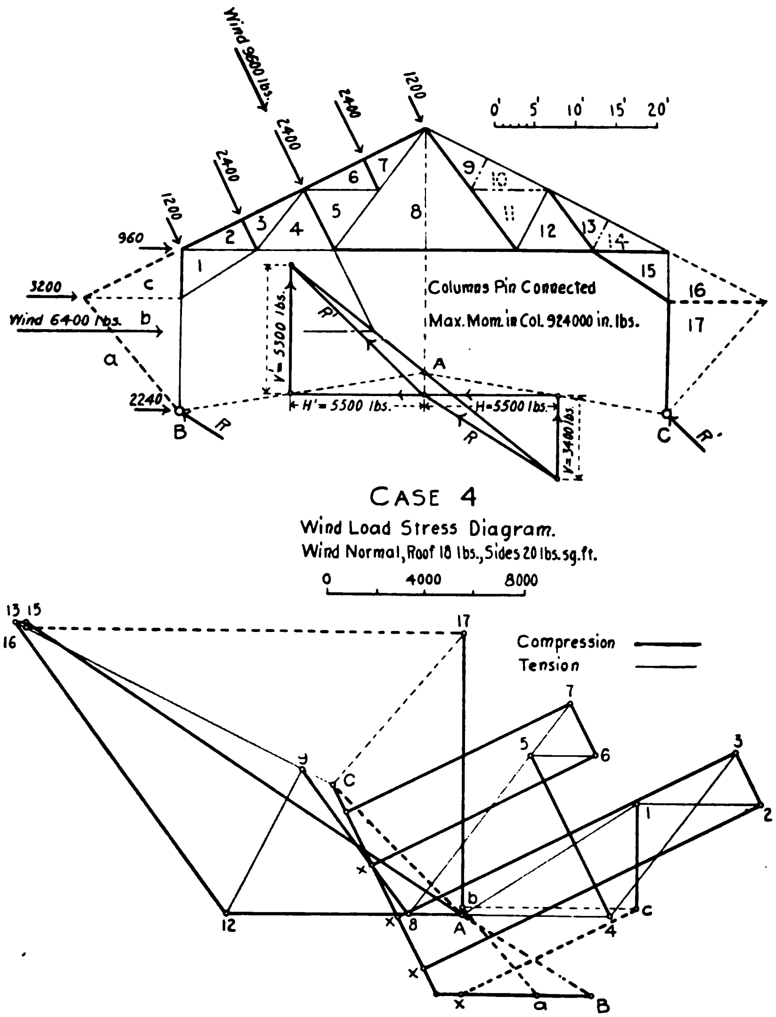


FIG. 11. WIND LOAD STRESS DIAGRAM, CASE 4.

reactions at B and C respectively. The stresses are calculated by beginning at the base of the column B as in Case 2. In the polygon a—B—A—b at b, A—B = R, a--B = 2240 lbs. and a—b and A—b are the stresses in a—b and A—b respectively.

The maximum shear in the leeward column below the knee brace is H^1 = 5500 lbs., above the knee brace is 12,800 lbs.; the maximum moment occurs at the foot of the knee brace and is H^1 x 14 x 12 = 924000 inch lbs.

CASE 5. WIND LOAD STRESSES, WIND NORMAL, COLUMNS FIXED AT BASE.

This is Case 4 with the base of the column moved up to the point of contraflexure. The maximum shear in the leeward column below the knee brace is 5500 lbs., above the knee brace is 5000 lbs.; the maximum positive moment occurs at the foot of the knee brace and negative moment at the foot of the column and is H^1 x 7 x 12 = 361200 inch lbs.

MAXIMUM STRESSES.

The stresses in the different members of the bent for the different cases are given in Table I.

The maximum stresses in the different members of the bent for (1) dead load plus maximum snow load; (2) dead load plus wind load, Case 4; (3) dead load plus minimum snow load plus wind load, Case 4; and (4) a vertical dead load of 40 lbs. per sq. ft. horizontal projection of the roof are given in Table II. The stresses which control the design of the members are underlined in (1), (2) and (3). By comparing these values with the stresses given in the last column the accuracy of the equivalent load method can be seen.

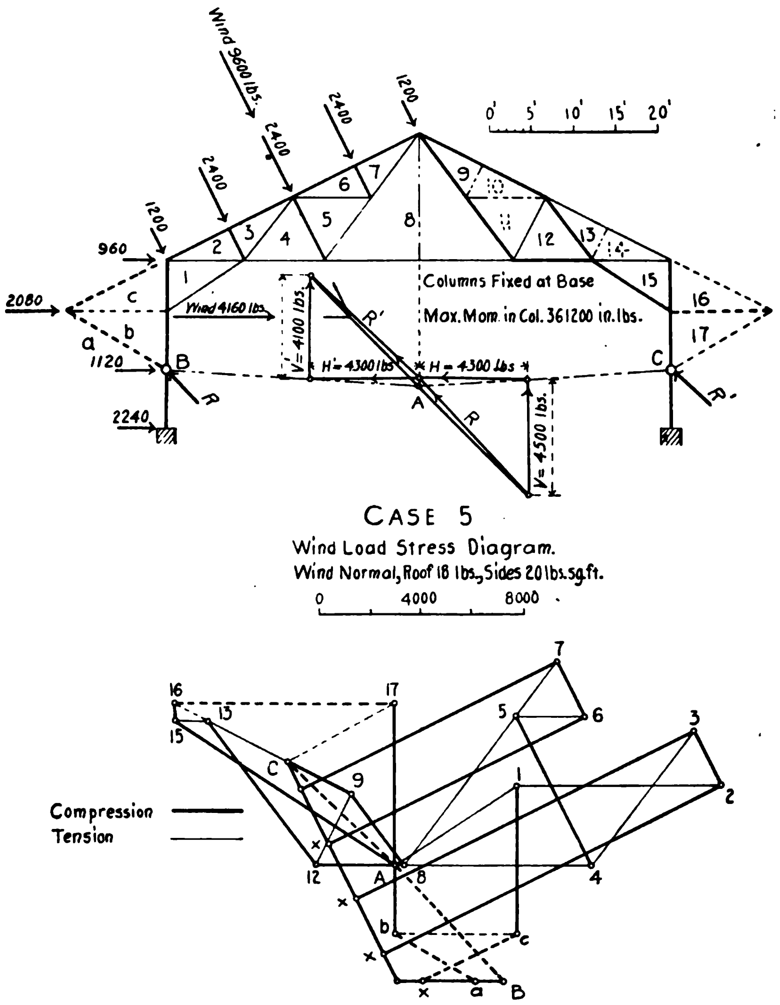


FIG. 12. WIND LOAD STRESS DIAGRAM, CASE 5.

TABLE I.

NAME OF PIECE	STRESSES IN A BENT FOR					
	DEAD LOAD	SNOW LOAD	WIND LOAD			
			CASE 2	CASE 3	CASE 4	CASE 5
X2	+9300	+18900	+3700	+2900	+15400	+14900
X3	+8800	+17600	+4900	+4000	+15400	+14900
X6	+8200	+16400	+ 400	+1400	+10200	+11200
X7	+ 7700	+15400	+ 1400	+ 3400	+10200	+11200
X9	+ 7700	+15400	− 6100	−1900	−1400	+ 2800
X13	+8300	+18600	−19800	−8600	−14600	− 3600
1-2	− 8300	−16600	+5700	+2800	− 5100	− 8000
2-3	+ 1100	+ 2200	+ 500	+ 500	+2400	+ 2400
3-4	−1200	− 2400	−6800	−4900	−8500	− 6700
4-5	+2200	+4400	+3800	+3000	+7300	+6600
5-6	−1200	−2400	− 600	− 600	−2600	− 2600
6-7	+1100	+2200	+500	+ 500	+2400	+2400
5-8	−2400	− 4800	−4300	−3300	−8200	− 7400
7-8	−3600	− 7200	−4900	−3900	−10800	−10000
8-9	−3600	− 7200	+ 7500	+3600	+7400	+3500
9-12	+2200	+4400	−6700	−3200	−6700	−3200
12-13	−1200	− 2400	+15200	+7400	+14800	+7000
Y-4	−7100	−14200	+ 2400	+ 800	− 6000	− 7700
Y-8	−4700	− 7400	+ 6800	+4000	+2200	− 400
Y-12	−7100	−14200	+14200	+7700	+9700	+ 2100
13-15	−8300	−16600	+ 4600	+3000	+ 500	− 1300
A-1			− 9000	−6200	−8500	− 6700
A-15			+22300	+11000	+21500	+10400

TABLE II.

MAXIMUM STRESSES IN A BENT FOR				
NAME OF PIECE	DEAD LOAD + MAX·SNOW LOAD	DEAD LOAD + WIND LOAD CASE 4.	DEAD LOAD + MIN SNOW LOAD + WIND LOAD CASE 4.	VERT. DEAD LOAD OF 40 LBS. PER SQ FT. OF HOR. PROJ.
X 2	+28200	+24700	+34300	+37200
X 3	+26400	+24200	+33000	+35200
X 6	+24600	+18400	+26600	+32800
X 7	+23100	+17900	+25600	+30800
X 9	+23100	+6300	+14000	+30800
X 13	+28200	-5300	+4000	+37200
1-2	-24900	-13400	-21700	-33200
2-3	+3300	+3500	+4600	+4400
3-4	-3600	-9700	-10900	-4800
4-5	+6600	+9500	+11700	+8800
5-6	-3600	-3800	-5000	-4800
6-7	+3300	+3500	+4600	+4400
5-8	-7200	-10600	-13000	-9600
7-8	-10800	-14400	-18000	-14400
8-9	-10800	+3800	+200	-14400
9-12	+6600	-4500	-2300	+8800
12-13	-3600	+13600	+12400	-4800
Y-4	-21300	-13100	-20200	-28400
Y-8	-14100	-2500	-5200	-14800
Y-12	-21300	+2600	-4500	-28400
13-15	-24900	-7800	-16100	-32400
A-1		-8500	-8500	
A-15		+21500	-21500	

CHAPTER III.

DESIGN OF MILL BUILDINGS.

INTRODUCTION. The general dimensions and the general outline of a mill building will be governed by the local conditions and requirements. Where circumstances will permit, as in smelters and mills, the interior arrangement of machinery, etc., should be determined on first and the building designed to suit. Failure to follow this rule will often cause needless expense in the building of special machinery.

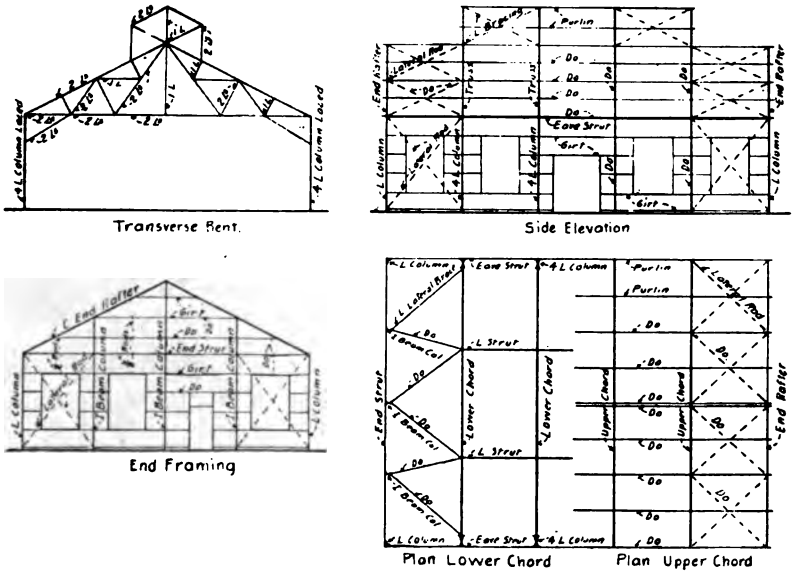
The proper unit stresses, minimum size of sections, and thickness of metal will depend upon whether the building is to be permanent or temporary, and upon whether or not the metal is liable to be subjected to the action of corrosive gases. For permanent buildings the writer would recommend *15,000* lbs. per square inch for allowable tensile and $15{,}000 - 55\frac{l}{r}$ lbs. per square inch for allowable compressive stress for direct dead, snow and wind stresses in trusses and columns, l being the center to center length and r the radius of gyration of the member, both in inches. For wind bracing and flexural stress in columns due to wind, add 25 per cent. to the allowable stresses for dead, snow and wind loads. For temporary structures the above allowable stresses may be increased 20 to 25 per cent.

The minimum size of angles should be 2″ x 2″ x ¼″, and the minimum thickness of plates ¼″, for both permanent and temporary structures. Where the metal will be subjected to corrosive gases as in smelters and train sheds, the allowable stresses should be decreased 20 to 25 per cent and the minimum thickness of metal increased 25 per cent, unless the metal is fully protected by an acid-proof coating (at present the best paints do little more in any case than delay and retard the corrosion).

The minimum thickness of corrugated steel should be No. 20 gauge for the roof and No. 22 for the sides; where there is certain to be no corrosion Nos. 22 and 24 may be used for the roof and sides respectively.

Stiffness and rigidity are of much more importance in a mill building than strength. The racking action of cranes, wind and eccentric loads is more injurious to the framework than quiescent loads, and care should always be used to avoid eccentric connections and to provide ample wind bracing. If it is neccesary to economize, the material should be saved in the main members and not in the bracing and details.

FRAMEWORK. The usual arrangement of the framework in simple mill buildings is as shown in Fig. 13. The different terms used in the discussion which follows will be made clear by an inspection of this diagram.



Transverse Bent.

Side Elevation

End Framing

Plan Lower Chord

Plan Upper Chord

FIG. 13. FRAMING PLAN OF A MILL BUILDING.

TRUSSES. The type of roof truss will depend upon the length of the span, clear head room, style of truss preferred, and other conditions. For spans up to 100 feet the fink type of truss is commonly used. The fink truss has the advantage of short struts, simplicity of details and economy. The stresses which control the design of the members, with possibly two or three exceptions, are those caused by an equivalent uniform load, thus simplifying the calculations of stresses (see Table II).

The outline of the truss will depend upon the spacing of the purlins and upon whether or not the purlins are placed at panel points of the truss. The most economical and pleasing arrangement is to make a panel point in the truss under each purlin. Taking the normal wind load on the roof at 25 to 30 lbs. per square foot, it will be seen in Fig. 18 that for No. 20 and No. 22 corrugated steel, when used without sheathing, the purlins should be spaced from 4 to 5 feet. If this spacing is exceeded a corrugated steel roof without sheathing is almost certain to leak.

In Fig. 14, (a) shows the form of a fink truss for a span of 30 feet; (b) for a span of 40 feet; (c) for a span of 50 feet; (d) for a span of 60 feet; (h) for a span of 80 feet, on the assumption that purlins are spaced from 4 to 5 feet, and come at the panel points. If trusses with vertical posts are desired, the triangular trusses (e) or (f), or fink truss (g) may be used. The truss shown in (i) is occasionally used for long spans, although it has little to recommend it except novelty. The truss shown in (j) is used where there is ample head-room.

The lower chord of the truss is usually made horizontal, as in (k); but by giving it a slight camber, as in (l), the appearance from below can be greatly improved.

Pitch of Trusses. The minimum allowable pitch of a roof will depend upon the character of the roof covering, and whether sheathing is used or not. For corrugated steel laid directly on the purlins, the pitch should preferably not be less than ¼ (6″ in 12″), and the minimum pitch, unless the joints are cemented,

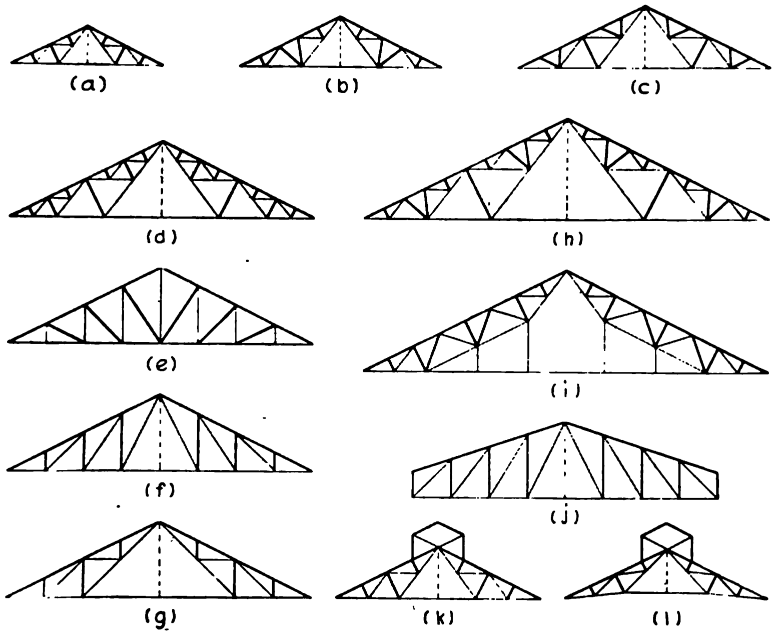


FIG. 14. TYPES OF ROOF TRUSSES.

should be 1-5. In case lumber sheathing is used, corrugated steel may be used with a pitch of 1-6 or 1/6 by cementing the joints.

Economic Spacing of Trusses. The weight of trusses and columns per square foot of area decreases as the spacing increases; while the weight of purlins and girts per square foot of area increases as the spacing increases. The economic spacing of trusses is a function of the weight per square foot of floor area of the truss, the purlins, the side girts, and the columns. For any given conditions the spacing which makes the sum of these four quantities a minimum will be the economic spacing. It is desirable to use simple rolled sections for purlins and girts, and under these conditions the economic spacing of trusses will usually be between 16 and 22 feet. The smaller value is about right for spans up to, say, 60 feet designed for moderate loads; while the greater value is about right for long spans designed for heavy loads. For long spans the economic spacing can be increased by using rafters supported on heavy purlins spaced at greater distances than would be required if the roof were carried directly by the purlins. This method is frequently used in the design of train sheds and roofs for buildings where lumber sheathing is used to support slate or tile covering, or where the tile are supported by angle sub-purlins spaced close together, as shown in Fig. 15.

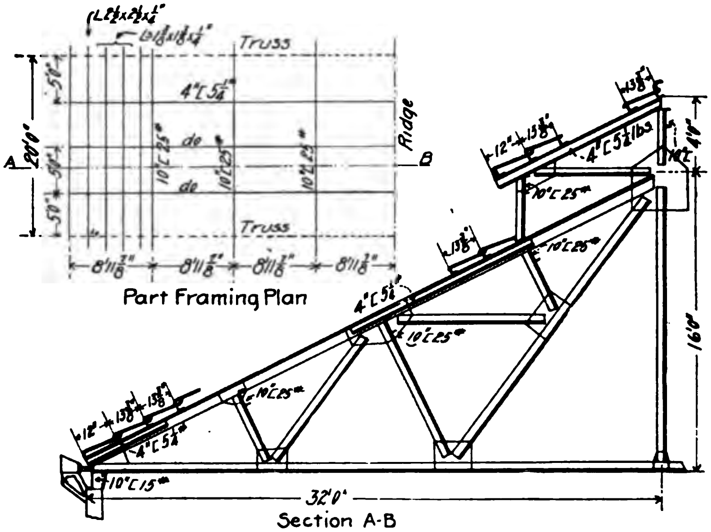


FIG. 15. ROOF FRAMING FOR TILE COVERING.

Truss Details. Riveted trusses are commonly used for mill buildings. For ordinary loads the upper and lower chords and the main struts and ties are commonly made of two angles back to back, forming a T-section, the connections being made by plates, (a) and (b) Fig. 16. The upper chord should preferably be made of unequal-legged angles with short legs turned out. Sub-struts and ties are usually made of one angle. Flats should not be used. Where two angles are used back to back they should be riveted together, as shown in Fig. 16, at intervals of from 2 to 4 feet.

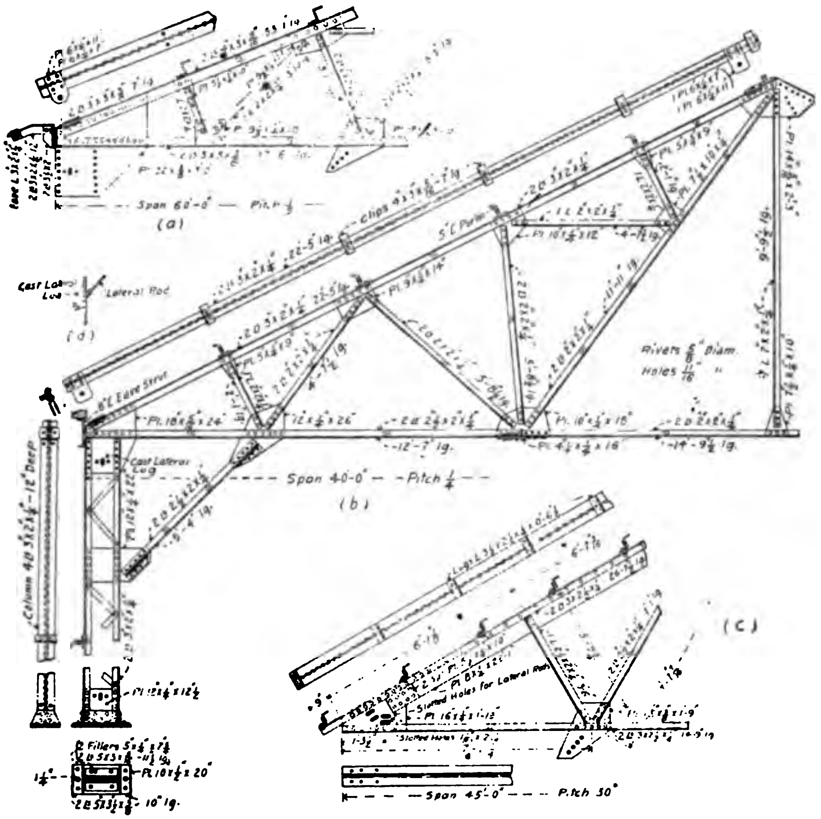


FIG. 16. TRUSS DETAILS.

Where the purlins are not placed at the panel points the upper chord must be designed for flexure as well as direct stress. The most common section used for the upper chord where the purlins are not placed at panel points is composed of two angles and a plate, as shown in (c) Fig. 16. The upper and lower chords are often made of two channels where it is necessary to support concentrated or moving loads directly on the chords.

Trusses may be fastened to the columns by means of a plate as shown in (a) and (b) Fig. 16, or by riveting directly to the

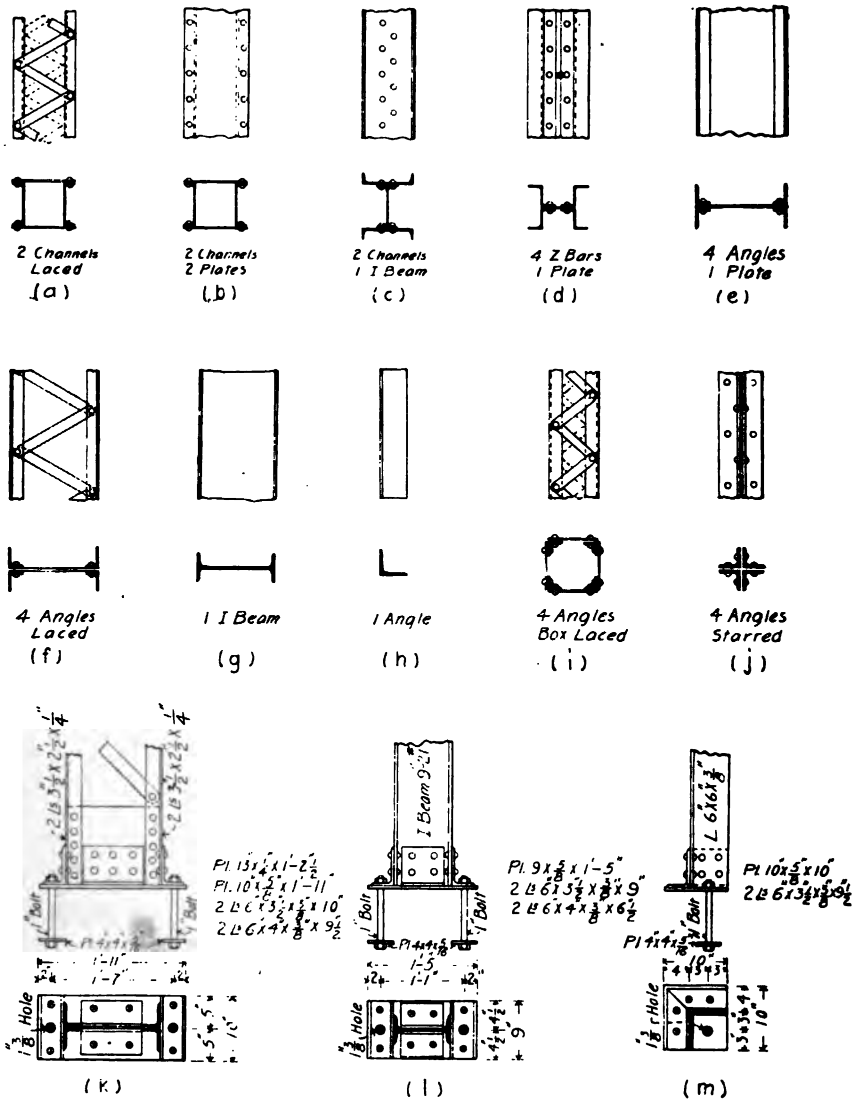


FIG. 17. COLUMN DETAILS.

column as shown in (c) Fig. 16. The first method is to be preferred.

Trusses for mill buildings are sometimes made with pin connections; however, riveted trusses are to be preferred on account of their greater rigidity.

COLUMNS. For side columns, Fig. 13, where the direct loads are not excessive, column (f) Fig. 17 composed of four angles laced is probably the best. A large radius of gyration in the direction of the wind can be obtained with a small amount of metal. The lacing should be designed to take the shear due to wind, and should be replaced by a plate, (e) Fig. 17, where the shear is excessive or where the bending moment at the foot of the knee brace requires excessive flanges. Details of a four-angle column are shown in (b) Fig. 16.

The I-beam column, (g) Fig. 17, makes a good side column where proper connections are made, and is commonly used for end columns, Fig. 13. The best corner column is made of an equal-legged angle with 4, 5 or 6-inch legs, (h) Fig. 17. Details of bases for the three columns above described are shown in (k), (l) and (m) Fig. 17.

Columns composed of two channels laced (a), two channels and two plates (b), two channels and an I-beam (c), and four Z-bars and a plate (d) Fig. 17, are used where it is necessary to carry heavy direct loads. Columns (i) and (j) Fig. 17, are not desirable columns, although sometimes used.

PURLINS AND GIRTS. Purlins are made of channels, angles, Z-bars and I-beams, (m) Fig. 19, where simple shapes are used. Channel and angle purlins should be fastened to the top chord by means of angle lugs as shown in Fig. 16. The channel purlin is the most economical and the I-beam purlin the most rigid. Girts are made of channels, angles and Z-bars, and are fastened as shown in Fig. 16. Where the distance between trusses is more than 15 or 16 feet, the purlins and girts should be kept from sagging by running ⅜ or ½ inch rods through the centers, the ends being fastened to the eaves and ridge (see end framing, Fig. 13).

Where columns and trusses are placed so far apart that the use of simple shapes is no longer economical, purlins and girts are trussed.

STRUTS AND BRACING. Four-angle struts made like the side posts, (f) Fig. 17, are often used for eave struts. Eave struts composed of single channels are more economical and are equally good in most cases. End rafters are usually made of channels. The sides, ends and upper and lower chords are commonly braced as shown in Fig. 13. The bracing in the plane of the lower chord should preferably be stiff. The diagonal bracing in sides, ends and upper chord is commonly composed of rods. Initial tension should always be thrown into diagonal rods by screwing up the turn buckles or adjustable ends. Stiff bracing should be made short and be brought into position for riveting by using drift pins; to accomplish this there should be preferably not less than three rivets in each lateral connection. Connections for lateral rods are shown in Fig. 16. In wide buildings the ends are sometimes braced against wind by means of a lattice girder placed inside the building in the plane of the lower chord.

COVERING. Mill buildings are usually covered with corrugated steel supported either on planks or directly on the purlins. Plank sheathing is tongued and grooved or ship-lapped, and is used from 1 to 2 inches thick. Where wooden sheathing is used it is necessary to bolt spiking pieces to the purlins and girts.

The roofs of mill buildings are also covered with slate or tile supported on a plank or concrete sheathing or carried directly on sub-purlins as shown in Fig. 15; and occasionally with some one of the following prepared roofings laid on plank sheathing: Sheet steel roofing, tin roofing, metal shingle roofing, asbestos roofing, rubber roofing, tar and gravel roofing, asphalt roofing, etc.

CORRUGATED STEEL. Corrugated steel is made from sheet steel of standard gauges and is either galvanized at the mill or is left black. The black corrugated steel is usually painted at the mill and always painted after erection. Paint will not adhere well to galvanized steel unless a portion of the coating is removed by the application of an acid.

The common standard for the gauge of sheet steel in the United States is the United States Standard Gauge, and this should be used in specifying weight and thickness.

The thickness and weights per square for black and galvanized sheet and corrugated steel are given in the table in Fig. 19. The weights of the corrugated steel in the table are for standard corrugations, approximately 2½ inches wide and ⅝ of an inch deep. If black corrugated steel is painted, add 2 pounds per square of 100 square feet.

Corrugated steel is also made with corrugations 5, 3 and 1¼ inches wide approximately. Corrugated steel with 1¼ inch corrugations, ⅜ of an inch deep is frequently used for lining buildings.

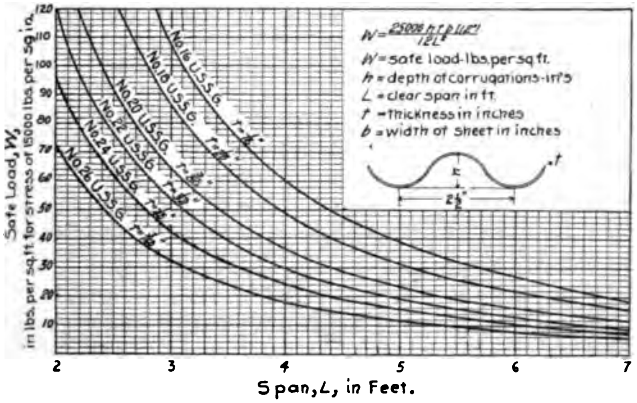


FIG. 18. SAFE UNIFORM LOAD IN POUNDS FOR CORRUGATED STEEL FOR DIFFERENT SPANS IN FEET.

The standard sheets of corrugated steel with 2½ inch corrugations are 28 inches wide before and 26 inches wide after corrugating, and will cover 24 inches wide with one corrugation side lap or approximately 21½ inches with two corrugations side lap, (a) and (c) Fig. 19. Special corrugated steel, (b) Fig. 19, can usually be obtained that will cover 24 inches with 1½ corrugations side lap.

Stock lengths of corrugated steel can be obtained from 5 to 10 feet, varying by one-half foot. Sheets of any length between 4 and 10 feet can be obtained directly from the mill without extra charge. Sheets from 48 to 5 inches long cost from 1/10 to 5/ cents per pound extra. Sheets from 10 to 12 feet long are very difficult to obtain and cost extra. Sheets can not be obtained longer than 12 feet.

The card of extras used by a prominent firm in 1901 is given below. These extras are to be added to the base price of flat black or galvanized sheets to obtain the cost. These extras are not subject to discount.

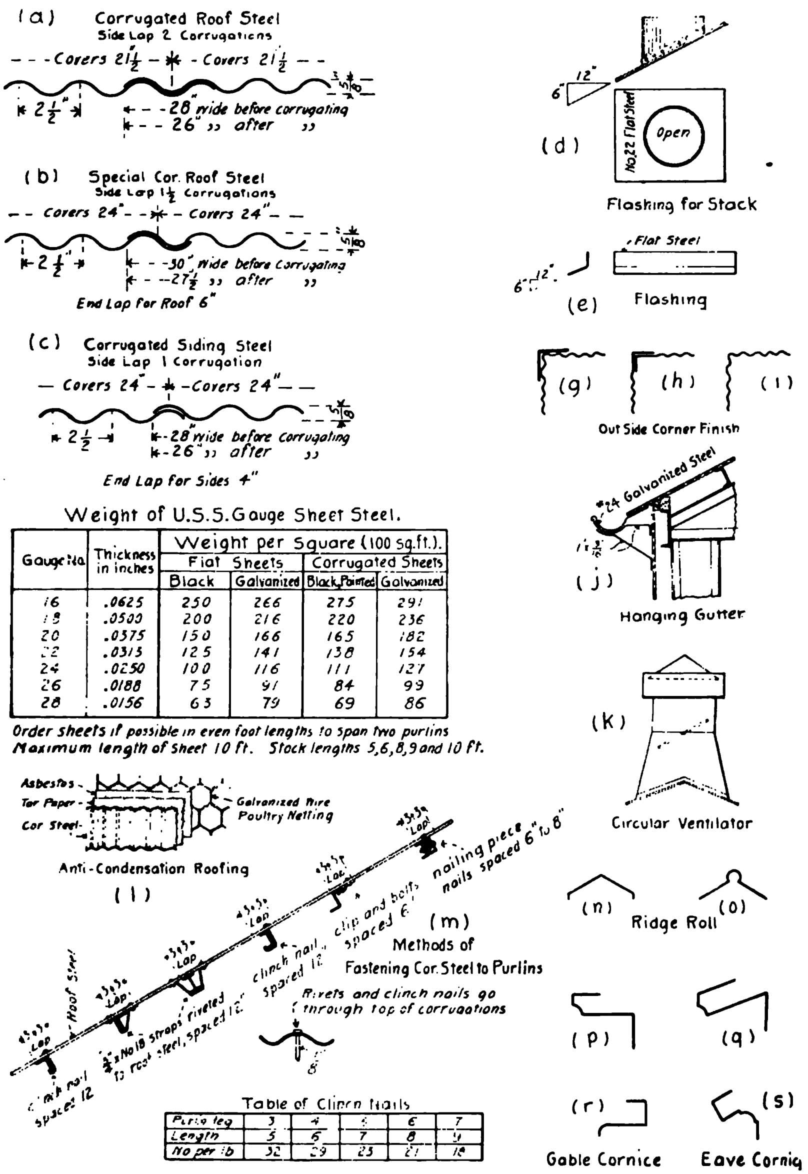
Card of Extras for Black or Galvanized Sheets.

For corrugating..	.05c.	per lb.
For painting with red oxide	.10c.	"
For painting with Dixon's graphite	.20c.	"
For painting with Goheen's carbonizing coating	.20c.	"
For all trimmings, etc., flashings, ridge caps, and louvres	$1.00	"

Galvanized steel in 1901 was quoted 75 per cent. off the standard list, F. O. B. Pittsburg; list being as follows:

List price of galvanized steel.

No. 10 to 16 inclusive	12c. per lb.
No. 17 to 21 inclusive	13c. per lb.
No. 23 to 24 inclusive	14c. per lb.
No. 25 to 26 inclusive	15c. per lb.



Weight of U.S.S. Gauge Sheet Steel.

Gauge No.	Thickness in inches	Weight per Square (100 sq. ft.).			
		Flat Sheets		Corrugated Sheets	
		Black	Galvanized	Black, Painted	Galvanized
16	.0625	250	266	275	291
18	.0500	200	216	220	236
20	.0375	150	166	165	182
22	.0313	125	141	138	154
24	.0250	100	116	111	127
26	.0188	75	91	84	99
28	.0156	63	79	69	86

Order sheets if possible in even foot lengths to span two purlins
Maximum length of Sheet 10 ft. Stock lengths 5, 6, 8, 9 and 10 ft.

Table of Clinch Nails

Purlin leg	3	4	5	6	7
Length	5	6	7	8	9
No per lb	32	29	25	21	18

FIG. 19. CORRUGATED STEEL DETAILS.

Black corrugated steel in 1901 was quoted as follows, F. O. B. Pittsburg:

No. 16 to 18 inclusive	2.2c. per lb.
No. 20 to 22 inclusive	2.6c. per lb.
No. 24 to 26 inclusive	2.7c. per lb.

Fastening for Corrugated Steel. Where sheathing is not used the corrugated steel is fastened with 8d barbed roofing nails ¾ to 2½ inches long, spaced 6 to 8 inches apart. The barbed nails 2½ inches long should be used for nailing to spiking strips and to sheathing wherever possible. The common methods of fastening corrugated steel directly to purlins and girts are shown in (m) Fig. 19. Nailing pieces should preferably be used where anti-condensation roofing, (l) Fig. 19, is used, or where the sides are lined with corrugated steel. The clinch nail is probably the most satisfactory fastening for usual conditions. The side laps are fastened together by means of copper rivets spaced 8 to 12 inches apart, or by stove bolts, Fig. 20.

The safe load per square foot for corrugated steel is given in Fig. 18. Data on the strength of corrugated steel are scarce, but all available to the writer agree with Rankine's formula, on which Fig. 18 is based.

Purlins are commonly spaced for a safe load of 30 lbs. per square foot as given in Fig. 18. If purlins are spaced wider than this the steel will deflect a dangerous amount when walked upon, and will leak snow and rain. Girts may be spaced for a safe load of, say 25 lbs. per square foot.

From an inspection of Fig. 18, it is evident that corrugated steel lighter than No. 24 is of little use for mill buildings. Nos. 26 and 28 should never be used unless for lining in cheap structures.

Lining. To prevent the condensation of moisture on the inner surface of the steel roof, and the resulting dripping, the ***anti-condensation roofing*** shown at (l) in Fig. 19 and in Fig. 20 is frequently used. The usual method of constructing this roofing is as follows:

Galvanized wire poultry netting is fastened to one eave purlin and is passed over the ridge, stretched tight and fastened to the other eave purlin. The edges of the wire are woven together, and the netting is fastened to the spiking strips, where used, by means of small staples. On the netting are laid one or two layers of asbestos paper 1-16-inch thick, and sometimes one or two layers of tar paper. The corrugated steel is then fastened to the purlins in the usual way. Three-sixteenth-inch stove bolts with 1x⅛x4-inch plate washers on the lower side are used for fastening the side laps together and for supporting the lining (see Fig. 20). The writer would recommend that purlins be spaced one-half the usual distance where anti-condensation lining is used. The stove bolts could then be omitted. Asbestos paper 1-16-inch thick comes in rolls, and weighs about 32 pounds per square of 100 square feet. Galvanized poultry netting comes in rolls 60 inches wide and weighs about 10 pounds per square.

The corrugated steel used with anti-condensation roofing should never be less than No. 22, and should be spaced for not less than 30 pounds per square foot. A less substantial roof will not usually be satisfactory.

An engine-house with anti-condensation lining on the roof and sides has been in use in the Lake Superior copper country for several years, and has been altogether satisfactory under trying conditions. The covering and lining of roof and sides is fastened by clinch nails to angle purlins and girts spaced about two feet apart.

A transformer building designed and built by the writer at East Helena, Montana, has anti-condensation lining on the roof as shown in Fig. 20, and is lined on the sides with one layer of asbestos paper, and 1¼-inch No. 26 corrugated steel. The black framework, the red side lining, and white roof lining made a very pleasing interior. This building after several years is giving entire satisfaction.

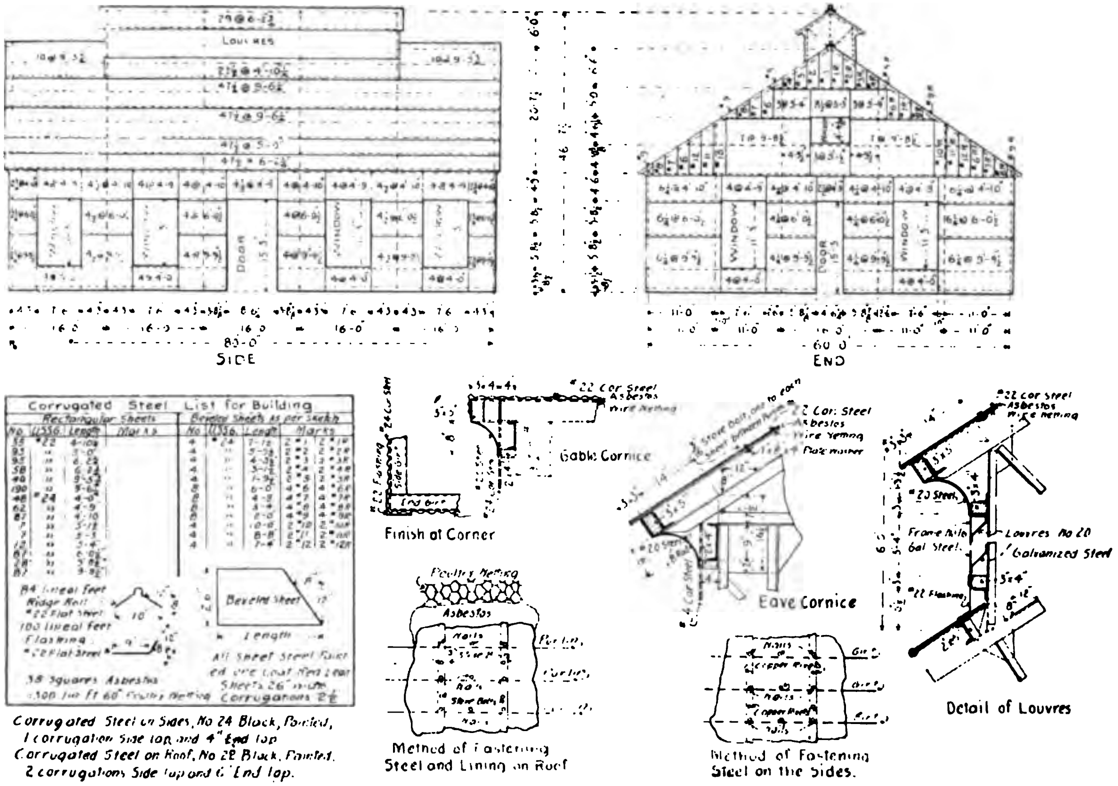
The air space between the inside and outside corrugated steel is sometimes filled with mineral wool. An expanded metal and plaster lining is very efficient and rigid, although somewhat expensive.

Plank lining is not very satisfactory on account of the shrinkage of the lumber and the danger of fire where it is used.

Details. In Fig. 19 are shown details of flashing, corner finish, ridge roll and cornice. Additional details are shown in Fig. 20. For ordinary mill buildings, the gable and eave cornice is made by extending the corrugated steel 8 to 12 inches beyond the building.

Corrugated Steel Plans. The shop plans, list and details for the corrugated steel for a steel mill building are shown in Fig. 20. Corrugated steel sheets should be ordered to cover two purlins and girts if possible. Bevel sheets should be ordered by number, and sheets should be split and reentrant cuts should be made in the field. All sheets should be plainly marked with the number or length. Sheets No. 22 and lighter may be bent in the field; heavier metal should always be bent at the mill.

TERRA COTTA TILE. Tile may be used for covering mill buildings laid (1) on plank sheathing, (2) on fireproof sheathing, or (3) may be supported directly on angle sub-purlins as shown in Fig. 15. The roof shown in Fig. 15 was constructed as follows: Terra cotta tile manufactured by the Ludowici Roofing Tile Co., Chicago, Ill., were laid directly on the angle sub-purlins, every fourth tile being secured to the angle sub-purlins by a piece of copper wire. The tiles were interlocking, requiring no cement except in exceptional cases. The tiles were 9x16 inches in size, 135 being sufficient to lay a square of 100 square feet of roof. These tiles weigh from 750 to 800 lbs. per square, and the cost is about $6.00 per square at the factory. Skylights in this roof were made by substituting glass tile for the terra cotta tile. This and similar tile has been used in this manner on a large number of mills and trainsheds with excellent results. Tile roofs do not require an anti-condensation lining to prevent condensation of steam on the inner surface.



Corrugated Steel List for Building

Rectangular Sheets				Beveled Sheets as per Sketch				
No	U.S.S.G.	Length	Marks	No	U.S.S.G.	Length	Marks	
55	#22	4-10½		4	#24	7-1½	2 #1	2 #1R
93	"	3-0"		4	"	5-3½	2 #2	2 #2R
95	"	6-2½		4	"	4-3½	2 #3	2 #3R
58	"	6-7½		4	"	3-1½	2 #4	2 #4R
40	"	9-5½		4	"	1-9½	2 #5	2 #5R
190	"	9-6½		8	"	6-0	4 #6	4 #6R
48	#24	4-0"		8	"	4-8	4 #7	4 #7R
62	"	4-9		8	"	3-4	4 #8	4 #8R
87	"	4-10		8	"	2-0	4 #9	4 #9R
[illegible]	"	5-1½		4	"	10-8	2 #10	2 #10R
[illegible]	"	5-5		4	"	8-8	2 #11	2 #11R
12	"	5-4		4	"	7-4	2 #12	2 #12R
82	"	6-0½						
28	"	5-8½						
87	"	9-9½						

84 lineal feet Ridge Roll #22 Flat Steel

100 lineal feet Flashing #22 Flat Steel

Beveled Sheet

Length

All Sheet Steel Painted one Coat Red Lead

Sheets 26" wide

Corrugations 2½

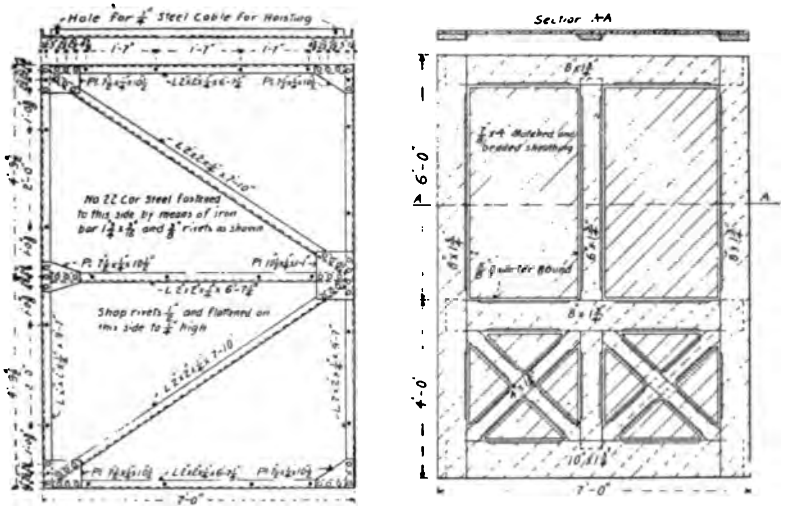
38 Squares Asbestos

300 lin ft 60" Poultry Netting

Corrugated Steel on Sides, No 24 Black, Painted, 1 corrugation Side lap and 4" End lap

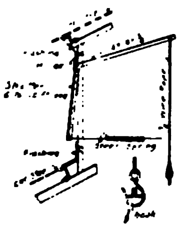
Corrugated Steel on Roof, No 22 Black, Painted. 2 corrugations Side lap and 6" End lap.

FIG. 20. PLAN FOR CORRUGATED STEEL FOR A MILL BUILDING.

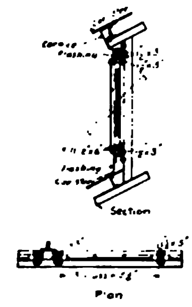

Hole for 1/4" Steel Cable for Hoisting
1'-7"
1'-7"
1'-7"
L 2x2x1/4x6-7 1/2
L 2x2x1/4x7-10"
No 22 Cor Steel fastened to this side by means of iron bar 1 1/4 x 3/16 and 3/8" rivets as shown
Pl 7 1/2x1/4x10 1/2
L 2x2x1/4x6-7 1/2
Shop rivets 1/2" and flattened on this side to 1/4" high
L 2x2x1/4x7-10
L 2x2x1/4x6-7
7'-0"
Section A-A
8x1 1/4
7/8x4 Matched and beaded sheathing
Quarter Round
8x1 1/4
10x1 1/4
6'-0"
4'-0"
A
A
7'-0"

Steel Lift Door

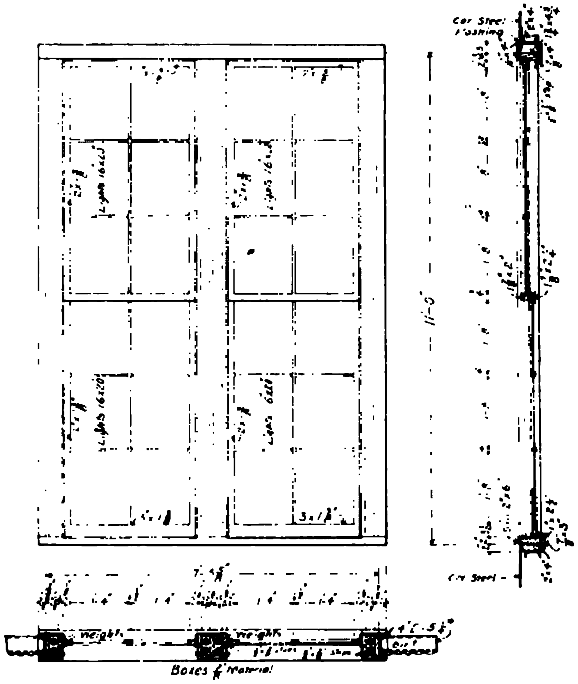
Sliding Wooden Door



Hinged Steel Ventilator



Hinged Glass Ventilator



Details for Double Window with Sash Weights

Fig. 21. DETAILS OF DOORS AND WINDOWS.

PAVING PRACTICE IN JOLIET.

BY H. A. STEVENS.

In attempting to relate and describe some of the present customs and methods of street paving in Joliet and, incidentally, touching upon various features that pertain to street improvements, the author believes that a better understanding of the local conditions can be obtained by stating briefly a few facts concerning the nature of the foundations, soil, and topography, and, perhaps, a little ancient history.

As originally laid out on the east and west banks of the Desplaines River, Joliet was founded on a rock. A rock so broad and deep that half a century of quarrying, formerly Joliet's chief industry, has scarcely lessened the visible supply of limestone by any appreciable amount. This rock, which is almost at the surface over the greater part of the business district, shelves off towards the east and is covered with gravel and small boulders; while to the west, beyond the first bluff, the covering consists of loam and stiff clay.

Some fifteen or more years ago, when the future greatness of this city began to be seen, a few of the wise men of the town conceived of the idea of establishing grades for its streets; and it was not long before ordinances were introduced in the city council setting forth grades and elevations to be established in various districts. As it happened these good men, laboring, perhaps, under recollections of the relative heights of the sidewalk and roadway of the business street in some country village, saw fit to name sidewalk grades in some instances from one to three feet higher than the grade they established for the roadways. The result is apparent to any person who will walk around a few squares in the business district.

It is probably needless to remark that the efforts now are directed toward eradicating the resulting conditions. Naturally, the earliest form of roadway improvements adopted, both in Joliet and the surrounding township, were made with Joliet bank gravel, which was to be had in abundant quantities at a small cost at the pits. Crushed cobblestone and crushed limestone supplanted the use of gravel where more expensive improvements were desired, the gravel being used to some extent as a binder or converting material for the crushed cobble.

In the year 1892 a few squares of six-inch cedar block pavement laid on a sand foundation was built, which is still in existence. In 1893 Joliet paved her first street under special assessment laws, the material also being cedar block. Since that date all pavements paid for by special assessment have been either brick, asphalt, or a macadam pavement of crushed cobble or limestone. More or less controversy over the relative merits of cobble and limestone has sprung up from time to time. In the author's estimation the advantages of superior hardness in the cobblestone is more than offset by the better binding quality of the limestone and the absence of rounded edges and corners which in the cobblestone pavement, especially after a season of dry weather, permits the stone to pick up and frequently necessitates the use of a steam roller in smoothing over the roadway.

The earliest brick pavements were laid with two courses of Galesburg brick. A little later several streets were paved with Hallwood block brick, laid on four inches of natural cement concrete. The latest practice has been to use Galesburg brick laid on six inches of natural cement concrete.

Jefferson street, the first street to be paved with sheet asphalt, was paved in the fall of 1897 and, in spite of a rather unfortunate experience with the material on that street, the popularity of asphalt for paving purposes has ever since been on the increase. Probably eighty per cent. of the petitions presented to the Board of Local Improvements asking for pavements request that asphalt be used.

Specifications under which all asphalt has been laid have provided that the material should be asphalt from Pitch Lake, Trinidad, or an asphalt equally as good for paving purposes.

On Jefferson street Bermudez asphalt was used. The author does not, however, attribute the partial failure of the work on that street to the material so much as to the season of the year in which it was laid; and, if he is correctly informed, to the gross incompetency and carelessness of the men engaged in laying the asphalt and preparing the mixtures.

Undoubtedly asphalt laid in freezing weather, with falling snow, with frost and ice in and on the concrete, and with material brought on the street having all the oil or flux burned out, cannot be expected to form an enduring pavement; so that the necessity for immediate repairs was not astonishing. With later contracts the overflow or land asphalt from Pitch Lake was used; and this has so far proven as satisfactory as the material from the lake itself. Several miles of streets laid with this asphalt are now passing through their third winter; and, although on some streets occasional small cracks are to be observed, nothing approaching a condition calling for repairs has appeared.

To an observer of asphalt pavements there is an element of the mysterious in the behavior of asphalt. Why two streets laid by the same men, with the same mixture, under absolutely similar conditions, as far as can be determined, should behave differently as they age is a puzzle. The author has in mind two such streets in Joliet, one known as North Chicago street, running north from Jefferson to Webster street; the other, South Chicago street, running from Washington street to Fifth avenue. These streets were laid in the summer months of 1899 by the Conway Paving Company, with the same mixtures, the same sand, the same asphalt, and the same proportions of flux. Yet North Chicago street is, as far as has been observed, almost entirely free from cracks or any sign of deterioration, except in spots where hitched horses have pawed holes in the gutters and along the edging of the street railroad tracks; while on South Chicago street during the first winter a number of hairline cracks appeared and have reappeared each winter only to close up during the following summers. The only reasonable explanation that can be offered for the phenomenon is that the traffic conditions on North Chicago street being much heavier than on South Chicago street, the wearing surface has acquired a greater compactness and density. This would seem to indicate that asphalt is a material fully as suited, if not more so, to a pavement on business streets of moderately heavy traffic as to residence streets and boulevards.

Natural rock asphalt is a material which has recently engrossed considerable attention in Joliet, owing to the strenuous efforts of the promoters representing the Federal Asphalt Company, who own large deposits in Kentucky, to find an opening for it in Joliet. The principal merits claimed for it are that the contained bitumen is 100 per cent pure, entirely free from organic or inorganic matter either chemically, combined, or otherwise; that it is also more fluid and similar to maltha, requiring the use of no fluxing agent; and that the pavement will endure changes of temperature, climate, weather, and water without being affected for periods greatly in excess of the life of artificial mixtures. Whatever may be the truth in regard to these claims, and the supposed advantages resulting therefrom, some streets recently paved with this material in St. Louis and in California would indicate that there are objections to its use, owing to the non-uniformity with which the bitumen is distributed in the rock and possibly to the character of the sand forming the rock. The author is convinced that in all asphalt work the skill of the operators and the nature and quality of the sand used, as well as the flux, are equally as important as the source of the asphalt. Sand which is too fine-grained and does not vary in size from the very minute particle to a grain a twelfth of an inch in diameter should never be used. Residuum oil as a flux should give way to a proper maltha with a high flashing point. Theresa avenue in St. Louis, claimed to be the best piece of asphalt paving in that city, was put down with Gilsonite from Utah, fluxed with California maltha. The sand used was pumped from the Mississippi River near the Merchants' bridge and uniformly variable in size.

One of our most difficult problems in asphalt work is to provide a suitable edging or marginal finish along the lines of street railroad tracks. If the asphalt is carried direct to the rail the repairs to the tracks and the vibration of the rails permit the admission of water along the rails to the foundation, which is frequently attended with serious consequences. Not only does the asphalt rot and break away, but in weather quickly alternating from warm to cold the water saturating the foundation becomes frozen and an upheaval of the pavement at the joints and along the rails is sure to follow. Aurora has recently passed through such an experience. On New York avenue, in that city, a very beautiful piece of asphalt work was completed last October. The asphalt surface was crowned to a perfectly true segment of a circle, the paving material being brought in direct contact with the rails on both sides, and the necessary groove for the wheel flange was made by running a car over the track while the asphalt was still hot. A more pleasing street surface would be hard to find; yet, to-day, at every joint, both on the inside and outside of the rails, there is a hump of asphalt which is the despair of the company that did the work and an eyesore to every resident of the street. The transformation was accomplished in a few hours of extremely cold weather after a period of snow and slush.

Preparatory to laying pavements in Joliet, on streets in which there are street railroad tracks, it is first required that the roadbed for the track shall be excavated six inches below the grade of the bottom of the ties and then rolled with a heavy steam roller. This space is filled with concrete, the ties being laid thereon, and the space between, around and over the ties is likewise filled with concrete to a depth suitable for receiving the binder course of asphalt. Along the rails, both inside and outside, brick are placed alternately as headers and stretchers, forming a toothed connection with the asphalt. A cement grout is used to fill the interstices between the brick and between the brick and the rails. This construction is far from perfect, and leaves much to be desired, the brick, where subject to the cross blows of passing teams, especially at intersections, becoming chipped and depressed and breaking away from the asphalt. Increasing the concrete foundation to twelve inches does not remedy the trouble, and cutting down an inch of sand bedding for the brick to barely enough to bed them seems only to aggravate the difficulty. In Chicago, at some of the boulevard crossings, perfectly squared and dressed granite blocks have been used for a distance of three feet out from the rail, which, so far as the author is aware, has proved satisfactory; but the lighter construction of Joliet seems to withstand the wear and traffic fairly well.

Brick pavements in Joliet have endured fairly well, everything considered; for, while there are no streets that are perfection, and some of the construction is light, especially where the brick are laid on four inches of concrete, the prices at which the work was done (varying from $1.07 per square yard for brick laid on four inches of concrete, in 1899, to $1.47 per square yard for two courses of Galesburg brick, laid in 1893), cannot be considered excessive. The weakness of the four-inch concrete construction is especially noticeable along the right-of-way of the various traction lines on which the plan of concreting under, between and over the ties was not adopted. On such streets the location and position of each tie supporting the rails is apparent, due to the slight settlement of the brick and foundations in the spaces between the ties. Heretofore sand fillers have been used exclusively, but all the new work is planned with cement grout for a filler. The undoubted efficiency of cement grout in protecting the edges of the brick from rapid abrasion certainly warrants the additional cost of the filler. In some recent brick construction in St. Louis, which was laid during the month of December, provision is made for the expansion of the pavement during warm weather by inserting

¾-inch scantlings adjoining each curb line, and also at intervals of fifty feet transversely across the roadway. Instead of removing these scantlings after the rolling and grouting of the brick is completed, and then filling the space with pitch, they are left in place and form part of the pavement. In other streets in the same city the transverse strips are being omitted entirely, while the strips along the curbing are inserted and removed and the space filled with an asphalt composition.

It may be of some interest to take up certain details of the planning and laying out of and providing for street improvements as practiced in Joliet. As you are all aware, under the State law providing for special assessments in municipalities having a population of less than 50,000 population, the Board of Local Improvements has no power to originate improvements, but can only act upon such petitions as are signed by property owners representing at least one-half of the property frontage along the line of the proposed inprovement. The hardships worked by this law are manifold. Many desirable improvements asked for by the residents of certain districts are blocked through the inability to provide, perhaps, for a necessary sewer or water-main to connect with an existing outlet or pipe, owing to the impossibility of getting signatures to a petition over part of the distance. When these difficulties are cleared away then follows the preparing of resolutions, the estimate of cost, profiles and, finally, an ordinance governing the improvement. After this has run the gauntlet of the City Council and County Court, and the assessment has been confirmed, we are ready to advertise for bids and award the contract. The proceedings usually occupy from two to four months. The first field work of actual construction is required to give the lines and grades for curbing. Usually the line is run down one side of the street on an offset of five or ten feet. Stakes are set every hundred feet on this line with a tack in the head for line and a crowfoot on the side for grade. After the curbing is set, a sketch or plan is made indicating the cur blines, intersecting streets, the location of catch-basins, and the calculated position of summits with the distances from the basins marked thereon. New levels are now taken on the curb as set at the indicated points for summits and basins, or wherever a break in the grade may occur, to furnish the necessary data for preparing the final instructions for paving for the contractors' use. These instructions take the form of a tabulated list of distances to be measured down from the top of the curbing to the surface of the finished pavement at all ruling points, as well as a statement of the crown to be given the roadway at different points. The contractor is then enabled with the assistance of three "T's," a straight-edge, and spirit level, to set all the pegs necessary for preparing his subgrade and finished pavement without further instrument work by the engineers. In some cities, notably Cincinnati and St. Louis, a straight stretch of level curbing or sidewalk is exceptional. On streets where a level curb might reasonably be expected, we find introduced summits and grades of one to three per cent ; the sidewalks and curbs rise and fall with the undulations of the roadway. Apparently this plan was adopted for the sake of preserving a uniform crown and cross-section in the roadway. It is the custom in Joliet, on level streets, to vary the cross-section and crown of the roadway so much as may be necessary to drain the gutters from the various summits to the basins without introducing the resulting grade into the curbs and walks. The crown will usually run from three inches at the summits to nine and twelve inches at the basins, depending on the width of roadway and distances between basins. It is not desirable to have gutters with less than 0.5 per cent. grade.

The location of catch-basins at street intersections, or at intermediate points in the block, is one on which opinions vary. The practice in Joliet has largely been to place them at the intersections of streets where the pavement has a maximum crown, thus facilitating the rapid draining of the cross-walks in wet weather. The cross-walks are formed by the use of a stone header set parallel with and six inches from the curbing so as to permit of an open gutter between curb and header, the elevation of the cross-walk being practically the same as the curbing. This does away with any step-down from the sidewalk to the pavement, and the author believes that this is a very desirable feature in any pavement. The ends of the header stone are rounded so that the pavement can readily be formed to the proper shape for the crosswalk. A seeming objection to this construction might be made due to the opening between curb and header, but in several years of use in Joliet it has never been found necessary, or even desirable, to crown the opening by an iron plate, or adopt other construction. In alley and driveway intersections it is also customary to avoid a step-down from the walks by carrying the pavement to the elevation of the return curbs and sloping gently towards the center for drainage.

In general, contract prices for street pavements have been satisfactory. Contracts are usually let at a stipulated price per square yard of pavement, per lineal foot of curbing, and per cubic yard of excavation. Excavation with a maximum haul of 2,000 feet costs 30 cents. Four-inch limestone curb, thirty inches deep, dressed and set in place, is worth 37 cents per lineal foot. Asphalt has varied from $1.51 per square yard in 1899, when 60,000 yards were laid, to $1.70 per square yard in 1900, at which rate about 17,000 yards were put down. Brick, under the present specifications, costs $1.35 per square yard, while macadam, of an average thickness of nine inches, is laid for 50 to 60 cents per square yard. Pit gravel loaded on the wagon at the bank is worth 10 cents, and sand 50 cents per cubic yard. Crushed limestone at the crusher brings 75 cents per cubic yard, and is delivered on the work under a city contract for 95 cents. Ordinary labor is paid from $1.50 to $1.75, varying with the demand. Union rates for team and driver are $3.50 per day.

In closing, a summary of the street improvements in Joliet may be of interest. There are about seventy-two miles of streets within the city limits paved as follows: 15.6 miles macadam; 3.6 miles asphalt; 3.3 miles brick; .6 miles cedar block. This makes a total of 23.1 miles of improved streets, or about 32 per cent., exclusive of roads which have been graveled.

DISCUSSION.

MR. H. A. STEVENS: As was stated, the wooden strips placed in the pavements in St. Louis to provide for expansion, are left in in some places while in others they are removed and the space filled with cement. There seems to be a difference of opinion as to the relative merits of the two methods.

All asphalt work is guaranteed for ten years and it must be kept in repair during this time. The ordinary specification requires that there shall be no depressions more than three-eighths of an inch under a straight-edge. The street must be kept so as to fulfill this requirement.

CAUSE OF RUMBLING OF BRICK PAVEMENTS.

DISCUSSION.

MR. W. C. LEMEN. The rumbling is a serious objection to brick pavements. The expansion joint seems to remedy the defect to a certain extent. Last year the speaker put in, in the City of Paris, 1900 feet of paving. A longitudinal expansion joint was placed along the curb and a transverse joint every hundred and fifty feet. The joint was made by putting a three-quarter inch strip in the pavement which was removed and the space filled with number six pitch. This did not entirely stop the rumbling, and in the work undertaken this year a longitudinal joint was made along the curb by laying six rows of brick next to the curb; the transverse joints were put in every twenty-five feet, being made one-half inch wide. This seemed to remedy the difficulty until, strange to say, when the weather was warming after a cold spell, the pavement rumbled again. The speaker believes that if the joint could be constructed of a material which will not harden when it becomes cold, it would be efficient.

NATURAL AND PORTLAND CEMENT CONCRETE FOR PAVING FOUNDATIONS.

DISCUSSION.

MR. G. W. GRAHAM: The speaker would like to have the statements of some of the members as to whether they are using natural or Portland cement for paving foundations. He has to put in sixty thousand square yards of paving in Freeport, and the people are not satisfied with natural cement.

MR. H. A. STEVENS: In Joliet natural cement is used in paving foundations. The speaker does not consider that this gives the best possible foundation, but it is giving fair satisfaction. There is a fair foundation to begin with, and natural cement concrete does very well.

PROF. A. N. TALBOT: It is quite common to use natural cement for paving foundations; and where the soil conditions are such that no extra stresses will come on the concrete, and where ditches have not been put in recently without being properly back-filled, there ought to be no difficulty in obtaining good foundations with natural cement concrete of a proper mixture. In Chicago the speaker has noticed that the use of natural cement concrete has been abandoned and Portland cement is used entirely. Of course that was on streets with heavy traffic. With the cheapening of Portland cement it undoubtedly will eventually be used for paving foundations altogether.

On a street in Champaign a foundation was laid with Portland cement. This was because the cost of the Portland cement and the local gravel was the same as natural cement and imported broken stone, and the gravel concrete gave a greater strength than the broken stone concrete.

MR. H. G. PADDOCK: Up to the present time natural cement has been used altogether for paving foundations in Moline. There have been several occasions to undermine the pavements and the foundations were found to be in good condition. However, since the price of Portland cement has decreased so much, it is being used.

The proportions used in the Portland cement concrete used in Chicago were, as the speaker remembers it, one, three, seven. A list of proportions used in the different cities was given in ***Municipal Engineering***. Most of them for Portland cement were one, three, six; quite a number, however, were one, three, seven.

MR. B. J. ASHLEY: In connection with the question of foundations, the speaker wishes to repeat what Mr. H. H. Gross, of Chicago, told him a year ago: Some sample brick pavement was put in on La Salle street by the Purington Paving Brick Company. Part of this was on a concrete foundation and part on ordinary macadam in which there was no cement whatever. The preparation of the foundation, both for the concrete and the macadam, was first-class. There was no difference in the two parts of the pavement after a number of years; the macadam had served the purpose fully as well as the concrete. He also told him of a pavement in the south part of the city, which had been laid on macadam, and, after a long number of years was fully as good as though it had been laid with a concrete foundation. This was quite a surprise to the speaker and he repeats it as being an important experience.

TRENCH FILLING.

DISCUSSION.

MR. B. J. ASHLEY. In the discussion of the shrinkage of earth embankments it was taken for granted that the material was loam or clay. Sand acts very much different than other kinds of soils, as the speaker discovered in doing some trenching in sand. About two years ago the speaker was call upon to put in a small waterworks system in a locality which was entirely in sand. It was necessary to place the mains about five feet below the surface, and the trenches were taken out with sloping sides so as to obviate curbing. The sand was thrown back loosely, the intention being to throw water on it after the trench was filled to settle it. It was found that this was not effective and another method was tried. Two men on horseback galloped back and forth on the trenches, but even this had little or no effect and finally the excess material had to be hauled off. Two years later the speaker visited the place and found no signs of where the trenches had been; there had apparently been no settlement. It is possible that the material just above the mains had settled but that the material above was so compacted by the horses that it formed an arch. This, however, does not seem probable. Later the speaker had occasion to make some embankments for foundations; and, in the light of his former experience, he decided that it was necessary to cast the sand into water in order to obtain complete settlement, and this was done.

The speaker had become quite interested in the question of the settlement of sand and decided to make some experiments which he has not quite completed yet. He has found that it is not possible to compact damp sand by tamping as much as by casting it directly into water. He has also found that pouring water on the sand has no effect unless it is completly flooded.

The conclusion is that the way to obtain the greatest density is to cast the sand into water; it is impossible to thoroughly compact it by tamping. In some of the experiments a tamping force of 1200 pounds was used, the sand being put in in three or four inch layers, but the volume could not be brought to within five to eight per cent of the volume when flooded. Some experiments were made in a cylinder about an inch and a half in diameter and fourteen inches long. By using perfectly dry sand and striking the cylinder it was possible to obtain a slightly greater density than by flooding; however, the effect of striking the cylinder can not be reproduced in practice. It was impossible to compact the sand as much by pressing it on top as by flooding it.

It is generally agreed among engineers that it is possible to compact clay to its orignal density by tamping it damp, but this is certainly not true of sand.

MR. J. L. CLARK. The experience of the speaker has been that if material is filled in six to eight inch layers and thoroughly flooded there will be no trouble from settlement.

MR. A. L. KUEHN. In connection with what has been said by Mr. Ashley in regard to sand it might be stated that sand, if moistened, will increase in volume from sixteen to twenty per cent. However, by shaking and striking the containing vessel it can be brought to its original volume. This does not quite agree with the flooding results of Mr. Ashley; but, perhaps, flooded sand is very much different from moist sand.

PROF. A. N. TALBOT. The speaker would like to hear from some of the City Engineers present as to whether they think it advisable from the standpoint of the city's welfare, financially and otherwise, to carefully back-fill all trenches whether a pavement is to be put in at the time or not. In other words, in our ordinary Illinois soil, if the earth is thrown back loosely and left to pass through several winters, will it be possible to put a satisfactory pavement over it?

MR. H. A. STEVENS. In Joliet the practice has generally been to compact the material in back-filling by flooding. The results are very satisfactory and it is much cheaper than tamping. The trench is kept well flooded while the material is thrown in, both in gravel and in clay soil. After the trench is filled a steam roller is run over it. The speaker has in mind one street which was paved with macadam and in the middle of which a trench was dug for a sewer. It was very desirable to put the street back into first-class condition. As the material was thrown back into the trench, a stream from a two and a half inch hose was kept on the work; and after the trench was filled, a steam roller was run over it. There has been no depression in the street since.

MR. H. G. PADDOCK. The first pavement in Moline was placed on a street in which there had been some trenching done about twenty-five years before for a sewer. The top surface was taken off to a depth of about eighteen inches. There was no sign of the trench either before the excavation or after, or when the surface was rolled with a four or five ton horse roller. The pavement, however, settled. Since that time all trenches have been flooded when they where back-filled and rolled with fifteen ton steam roller, and there have been no signs of depressions.

MR. J. C. QUADE. The speaker agrees with Mr. Stevens that flooding a trench in doing the back-filling is the best and the most economical method of compacting the material. This can be done very easily in trenches in which there are water mains without damage. However, if this method is permitted in sewer work, the cement should be given time to set before any water is thrown into the trench, or the sewer will be damaged, especially if there is a good deal of water in the trench in the first place.

The speaker recalls an experience which he had while working on some pavement for Professor Talbot. A trench had been made in the street some twenty years before for a drain tile. There were no signs of this trench, either before or after the excavation had been made, but after the surface was rolled the line of the trench could be detected. The speaker believes that where a ditch is not tamped, a crust is formed by wagons which supports the surface, removing all signs of the trench.

"CIVILIZATION AND WAGON ROADS."

BY IRA O. BAKER.

"The roads of a country are accurate and certain tests of its civilization." Considering roads in the broadest sense as means of communication and transport on land, and thus as including railroads, wagon-roads and city streets, it is true that the degree of civilization which any people have attained is indicated by the condition of their roads; but if by roads is meant only those traversed by wagons, it is not true that the condition of the roads measures the civilization of a country. The condition of the wagon-roads is dependent upon other elements than the state of civilization; as, for example, upon the density of population, the frequency of the use of roads, the character of traffic, the kind of crops, the topography, the opportunity for drainage, the proximity of suitable road-building material, etc. As a rule the condition of the wagon-roads is no indication of the degree of civilization of the local community.

The problem of good roads depends in every case upon local conditions, and no general solution can be found. The broken stone road in the moist climate of France is an ideal road, but in the dry climate of Northern Italy it becomes a dusty nuisance. The principles and practices of France, England, Germany and Switzerland, although most excellent for those countries, are not necessarily applicable in this country. The broken-stone road may be well suited to the soil and climate of England, but who can foretell the effect of sticky Illinois mud on such a road? The wagon-ways of the leading European countries represent the experience of centuries in road-building, and the chief motive in the construction of many of them was military rather than commercial or social. These countries have a dense and comparatively wealthy population, an undulating surface, affording ready drainage, and an abundance of suitable material for constructing permanently good roads; while in the United States are immense areas having a sparse and comparatively poor population, without gravel or broken stone suitable for road-building purposes. Further, the advent of the railroad has materially changed the condition with reference to many of the European wagon-roads.

The first inhabitants of this country were too fully occupied in subduing the wilderness, establishing homes, opening farms to provide the necessaries of life, and setting up the framework of a government, to give much attention to the conveniences and comforts of transportation, and hence, their wagon-roads were of the crudest and poorest sort. Later, just as an extension of the population to the West necessitated the development of better means of transportation, the introduction of the railroad made less important the wagon-roads and engrossed the attention of the population of the new territory. In a large part of the United States the railroad has been the pioneer, and rendered unnecessary long lines of wagon transportation. At present this country is so well supplied with excellently managed railroads that the chief function of the wagon-road is to afford easy communication and transportation between neighboring farms, and between the farm and the nearest railroad station. Thus the problem of good roads has become a local question both with respect to the community the road serves and to the materials and methods most suitable for use in the construction.

The writer has collected the following data for the benefit of the good-road enthusiast who is ever so ready to compare the justly celebrated road system of France with that of America, much to the disparagement of the latter: France has one mile of road for each 0.66 square mile of area, Massachusetts one mile of road for each 0.48 square mile of area, New York 0.61, Illinois 0.53, and New Jersey 0.43. In other words, America has about as many roads per square mile as France. Again, France has one mile of road for each 119 of population; Massachusetts 164, New Jersey 100, New York 90, and Illinois 46. The population of France is about four times as dense as that of Illinois. Road laborers receive 50 cents per day in France, and $1.50 in America. The annual expense on roads of France is $143 00 per mile of road, $223 per square mile, and $1.39 per inhabitant; in Massachusetts $22.17 per mile, $50.72 per square mile, and 46 cents per capita; in New Jersey $43.24 per mile of road, $100.06 per square mile, and 43 cents per capita; in New York $30.00 per mile of road, $49.20 per square mile, and 33 cents per capita; in Illinois $34.86 per mile of road, $65.80 per square mile, and 77 cents per capita. In other words, France is spending nearly four times as much per mile of road as Illinois, three and a half times as much per square mile, and about twice as much per capita.

The good-road enthusiast who writes so glibly that the condition of the road indicates the state of civilization and who reiterates the praises of the stone roads of France and England, is prone to denounce the prairie roads of the Mississippi Valley and of Illinois in particular, as the worst imaginable. On the contrary, the author believes that the roads in the "corn belt" of Illinois are among the best in the country, and that with a little intelligent care they can be made on the whole second to none. The earth roads in the prairie portion of Illinois are usually excellent eight, and some years ten months of the twelve; and are reasonably good for ten or twelve months of the year; but there are times in the spring when the frost is going out of the ground that they are practically impassible for loads. However, through the underdrainage of the soil by tile and through a better care of the surface, the period of impassibility is comparatively short. There has been a very great improvement in these directions in recent years, but there is still room for discriminating improvement.

The earth roads of the prairie states are easily cared for and usually are kept in reasonably good condition. If you think the roads of the "corn belt" are bad, go to a locality where sand predominates; and after wallowing through sand half-hub-deep, you will probably long for the mud roads of Illinois. Or, go to a hilly or even an undulating locality, where the roads are gullied out by the rains and where the stones stick above the ground or roll around on the surface, and after grinding along on the pebbles, jolting over the stones, and racing up and down hill for a half day, you may prefer the smooth, level roads of Illinois for business purpose and perhaps for pleasure driving. The hill country is a very good place to spend a summer's vacation, provided you do not attempt much driving; but for everyday use there are some advantages in favor of prairie roads.

Unfortunately, the good-road enthusiast has sought to improve the roads of the prairie states by trying to prove to the farmer that he would save vast sums of money in the marketing of his produce by the construction of stone roads. The farmer has been marketing his farm products for a good many years, and has not been conscious that it has cost him much, if anything; and he can not see how he will save money by spending large sums to build and maintain expensive stone roads, when all of his transportation on "poor" roads costs him little or nothing. Many of the farmers of Illinois have had experience with hard roads in the Eastern States, and believe as an octogenarian, whose letter shows him to be an educated, observant, public-spirited man, wrote to the author a short time ago: "I feel satisfied from my own experience in Illinois and in Massachusetts, that if we had hard roads in Illinois the increased expense of repairing wagons and shoeing horses and of the bother and cost of having a lame horse in the barn eating his head off, would be more than the total cost of marketing our products over earth roads. I do not believe that I would have received one dollar more for the produce I have delivered to the railroad station for the last forty years, even if the roads had been of the best stone or brick." The farmer has turned an indifferent or hostile ear to all such advocates; and if these arguments have accomplished anything, it has been to retard road improvement

For example, what is the probable effect upon the farmers when the council of a city having no pavements appoints a committee of citizens to urge farmers to build hard roads costing $10,000 per mile past farms worth $5,000 with a house every half mile, to connect with an unpaved street with houses (some of them $10,000 ones) every hundred feet, as was done to the personal knowledge of the writer? The said committee has not yet had a meeting!

With due defference to the would-be road reformer, it is not true economy to greatly increase road expenses to permit the farmer to use the roads a comparatively few more days in the year. For some years the writer has been hoping to find time to prepare an article to show that the sidewalks in town should be covered with a roof. After a little study anyone will be astonished at the arguments that can be advanced for this proposition. Just think of the expense of umbrellas, of the persons who have had a long spell of sickness, which possibly resulted in death because of having been caught in a shower, and of the suits of clothes that have been damaged by getting wet, of the time lost by the business men in waiting until the rain is over, not to speak of ruined Easter bonnets, and the cost in time and money of unnecessary shoe blacking. The arguments may be made to closely parallel those used to prove that the farmer should build high-priced roads so that he may haul heavy loads on the road any day of the year, and can easily be made equally convincing.

Although the road question is local in its nature, it is not unimportant in its relation to the political and social development of the country. The political and social life of the states, as well as their economic advance, is to a considerable extent determined by the readiness with which the people obtain the association with one another, which leads to the development of a public spirit. In closing the writer urges (1) that the advocates of road improvment should base their arguments on social, educational, and political grounds and not alone, or even chiefly, upon commercial needs; and (2) that much more attention should be given to the local conditions; and finally (3) that it is not wise to advocate high-priced broken stone roads as substitutes for poorly cared for earth ones.

CAN BROKEN STONE ROADS BE BUILT IN THE CORN BELT OF ILLINOIS WHICH WILL NOT BE PICKED TO PIECES BY THE STICKY MUD?

DISCUSSION.

MR. J. L. CLARK. In the vicinity of Momence the mud is of the sticky variety. It is sometimes so bad that it is necessary to stop every two hundred feet to poke it out of the wheels. Stone has been put on these roads. The work was not done scientifically, but the material was just dumped on the roads. For the first year the stone picks up badly, but after that the top surface seems to become cemented together and the road wears out uniformly. When the speaker saw the road at Bloomington last year his ideas on the matter were somewhat shaken. He went to Indiana, in the vicinity of Lowell. Here he found that gravel was used among other road metal. The top surface of the gravel is compressed and cemented together; and after a little repairing at the end of the first year there is no trouble from picking up.

REPORT OF THE COMMITTEE ON ROADS AND PAVEMENTS.

For the information and possible instruction of the members of the Society, your committee has arranged with our distinguished local member, H. A. Stevens, City Engineer of Joliet, for a paper giving a historical and outline description of the pavements of the city in which we hold our present meeting. This paper was solicited in the belief that one of the advantages of membership in this Society is the privilege of becoming acquainted with the municipal work of the various cities in which we hold our annual meetings.

It is difficult to find anything new or valuable to record on the subject assigned to this committee. The law relating to the special assessments for pavements seems to be reasonably satisfactory, and under its provisions the smaller cities are gradually paving their main streets. Brick continues to be the leading paving material for light-traffic streets in localities remote from quarries of rock suitable for macadam. The low price of cement the past year has been favorable to the introduction of concrete foundations—which usually is a desirable form of construction. However, an inspection of the streets of almost any city will show numerous depressions over trenches dug for sewers, water pipes, gas conduits, etc., often notwithstanding the use of concrete. This shows the importance of the careful back-filling of all trenches, and shows also the necessity for thoroughly rolling the subgrade. Most of the depressions in the pavements run longitudinally with the street, which shows that the rolling was more effective on the transverse trenches than the longitudinal ones. The only way to prevent these depressions is to roll the street thoroughly both longitudinally and transversely, which practically requires the use of a steam roller.

The bill introduced into the last legislature for state aid for hard roads was not considered on its merits even in committee—primarily on account of the shortness of the legislative session. The meager discussion of the proposal in the newspapers raised a question that properly falls to the members of this Society to investigate. The proposition to build hard roads is practically a proposition to build crushed stone roads, since gravel suitable for road building is limited in both quantity and distribution, and since brick, the next cheapest material, will usually cost more than crushed stone. In the discussion of the hard road bill, the claim was made that there was some doubt whether a crushed stone road could be constructed in the "corn belt," which would not be picked to pieces by the sticky mud of that part of our state. In proof of this claim the complete failure of two or three very crude attempts at stone road construction was cited; but most of the examples were without value, owing to the unscientific methods of construction employed.

However, one of the examples is instructive. The members of this Society will remember that at the time of our last annual meeting, in Bloomington, there had recently been completed at that place about three miles of macadam road built of chert (improperly, but commonly, called novaculite) imported from Elco, a small place about 20 miles northwest of Cario. At the time of our meeting, some of the members of the Society inspected the road and found signs of a tendency to pick up; and an examination late last spring showed that the road had deteriorated rapidly under the pulling action of the mud. The surface was rough and uneven, and full of cradle holes.

The material employed in this road was reasonably satisfactory, and was much better than most of the material that will probably be used in future road construction in Illinois. Chert has a fair degree of binding power in itself, and the particular sample employed in the Bloomington roads is associated with a ferruginous clay which has a very high cementing power. This road was not built with the utmost care, in that it was not sprinkled during rolling and was not rolled as much as is usually considered necessary for the best results. It is ordinarily considered economical to sprinkle and roll until the surface is puddled, i. e., until a thin grout flushes to the surface and a wave of dirty water flows in front of the roller. The three miles of road referred to above were built in two sections; and the section which according to local reports best stood the wear and tear of a winter's use, is favorably situated as far as the action of the mud is concerned, since it connects at one end with Bloomington's system of brick pavements, and has comparatively few side roads connecting with it. If a road constructed of the grade of material employed at Bloomington, built with the care given to that construction, and as favorably located as that road, is picked to pieces in a single winter, it is desirable to inquire whether it is possible to build any stone road on the sticky soil of the corn belt which will not similarly fail?

Chert (novaculite) has been used at Cairo to a considerable extent, but the experience there is only an uncertain guide for the central portions of the state, since the unpaved streets of that place have been filled with sand from the Mississippi and consequently are not to be compared with the soil of the corn belt for stickiness. The chert pavements of Cairo have not been built with the utmost care, but have given reasonable satisfaction. At Jackson, Tenn., chert has been used with great success, but here again the soil is sandy and hence this experience is without value for Central Illinois.

Your committee is aware that limestone roads have been built in Northern Illinois, and has sought to secure information on this point by correspondence, but the replies have been so few, and so long delayed, and so brief, as to be practically useless in throwing light upon this subject. In all probability valuable data can be obtained only by an expert upon the ground, and possibly only by an expert thoroughly conversant with the original situation and with the details of the construction while in progress. The items about which it is desirable to have full information are as follows:

The nature of the soil, the drainage of the roadbed, the preparation of the sub-grade, the character of the stone employed, the sizes and thickness of the stone in the several courses, the amount of rolling each course received, the width of face and weight of the roller used, the amount of sprinkling, the length of time the road has been in use, the expense for repairs, the amount and nature of the traffic, the width paved, the grades, etc. Doubtless many, perhaps most of the stone roads are not rolled, but are left to be consolidated by the traffic, in which case data should be obtained as to the degree of consolidation after specified amounts of travel.

Apparently this is an investigation belonging peculiarly to the membership of this Society, and your committee begs permission to express the hope that some members of the Society can be found who reside in the regions where crushed stone roads are common and who will investigate this subject and report their conclusions to the Society, and by so doing add to the reputation of the Society and advance the science of road-building.

Respectfully submitted,

IRA O. BAKER,
For the Committee.

THE STATE DAM AND TAIL RACE AT JOLIET, ILL.

BY JOHN W. ALVORD.

The State of Illinois owns a very valuable water-power in the City of Joliet, which is now leased to the Economy Light & Power Co., and is operated by them. The water-power originated in the construction of the Illinois and Michigan Canal many years ago, at which time the State acquired the necessary lands and built what was then known as Dam No. 1, just north of Jackson street bridge. It also built Dam No. 2, which was located just north of Jefferson street bridge. These dams created two basins, known as the upper and lower basin, by means of which the original canal was enabled to obtain navigation by slack water over a distance of about a mile and a half of the Desplaines River, and also to effect the crossing of that stream. Incidentally there was created at Dam No. 1 a fall of ten feet and a variable water-power of about 500 gross horse-power.

In 1898 the Sanitary District of Chicago, in providing for the completion of their work, took up the question of passing the maximum flow of their new channel, together with the flood water of the Desplaines River, through the City of Joliet. Any consideration of this problem which would leave the State canal uninjured involved radical changes and expensive construction in the dams and locks then existing. The maximum amount of water to be provided for would be, according to the estimates of the Sanitary District engineers, about 1,500,000 cubic feet per minute in times of flood. A preliminary contract for these changes was made between the Commissioners of the State and the Trustees of the Sanitary District, in which the general nature of the changes were outlined, and it was agreed that the work should be done by the

Sanitary District, subject to the control and approval of the Canal Commissioners.

When the detail plans of the Sanitary District were received, the author's firm was called in to report upon the same, and in the course of the investigation which followed it was developed that the possible future power which might be utilized at Dam No. 1 would be seriously curtailed by a proposed reduction in height of 3.6 feet. Other features of the proposed plans were considered as injuring the State and its canal, and, as the report gave rise to prolonged and expensive litigation, in which no less than sixteen expert hydraulic engineers of national reputation were called in, the author takes the liberty of quoting its most important passages:

"As intimated in our preliminary report, the preservation of the level of the upper basin has seemed to us to be an important feature. It is quite evident that any material fluctuation of this basin, especially below the present and proposed level, would seriously affect the navigation of that part of the canal. This level is maintained at present by the fixed crest of Dam No. 1. It may have a maximum variation of 3.5 feet, due to the effect of floods in the Desplaines River. It is proposed to lower the crest of this dam 3.6 feet, so that the minimum flow of the drainage channel (300,000 cubic feet per minute) will maintain the same level as at present, the floods of the Desplaines River raising this level as much as they do now.

"In this connection it may be noticed that hydraulic formulas for the flow of water over weirs are based upon measurements made upon crests, the depth upon which has not much exceeded two feet. In applying formulas derived from such measurements to flows of 1,500,000 cubic feet per minute, as is here contemplated, it is evident that the results must be somewhat approximate, and that the exact level for large quantities can only be known within perhaps 15 or 20 per cent. of the truth.

"The quantity of water to be passed over the proposed crest of Dam No. 1 is also variable, ranging, in our judgment, all the way from 246,000 cubic feet up to the maximum above mentioned.

"We would call attention to the fact that such a flow over the proposed crest would result in lowering the level of the upper basin to less than 4.5 feet over the sill of lock 4, which is about 18 inches below proper navigable depth.

"If remedy for these conditions be sought in raising this fixed crest to the height of the present dam, we would observe that the flood heights, due to the ultimate capacity of the drainage channel, combined with the maximum floods of the Desplaines River, would require extensive constructions over those proposed in the present plans. * * *

"It has already been pointed out that it is essential to the maintenance of the proper water level in the upper basin to retain the crest of Dam No. 1 as it has existed the past fifty years. This is as important for the power as for the navigation interests, and especially with reference to the provision in the contract between the Commissioners of the Illinois & Michigan Canal and the Trustees of the Sanitary District, by which the latter agree to maintain this head undiminished. We do not see how this can be done with a lower crest with that certainty which at all times is necessary.

"With reference to the capacity of the tail race at this point, with a view to the future development of all the available power, we would suggest that it is feasible to open such a tail race without acquiring additional land south of Jackson street. This can be done by removing the first pier of the bridge west of the east abutment, and substituting a single span where two now exist. Also by making some change in the alinement of the eastern abutment. By these changes a width of 65 feet and a suitable curve for a tail race cut to a depth of 25 feet into a solid rock, which, with the properly excavated outlet, will pass 560,000 cubic feet per minute with a mean velocity of 5.5 feet per second. When this quantity is passing through this outlet in the tail race there will be a lessened flow over the crest of the dam to retard its exit into the channel."

The above quotation fairly represents the position of the Canal Commissioners' contention. The position of the Sanitary District being, in brief, that having created the additional flow of 300,000 cubic feet per minute by means of their main channel, which would create about 6,000 gross horse-power at Dam No. 1, they were not necessarily obliged to bestow the use of this additional water upon the State at Dam No. 1 for power purposes, and thereby place themselves under the necessity of expensive constructions above that dam for the purpose of controlling the flood water of the Desplaines River. They, therefore, proposed to cut the heighth of the dam down so that with the increased quantity of flow caused by the opening of their channel the ordinary elevation of the water above Dam No. 1 would still be as near as possible what it always had been in times of normal flow of the Desplaines River, and the case turned largely upon this point, it becoming an interesting question of hydraulics as to whether this level could be maintained with accuracy sufficient to maintain navigation on the canal.

The Sanitary District was represented by a large number of formidable hydraulic experts who testified that this could be done accurately and properly, and the attorneys for the State, on the advice of the author, collected an equal number of formidable experts to watch their evidence. The court room scintillated with formulas, diagrams, and co-efficients until the judge was fairly dazzled with the array of talent exhibited.

The trial was held in the City of Joliet, in the Court House, and lasted some six weeks, it taking the Sanitary District nearly all of that time to put on record its evidence of fact and expert opinion. During these six long weeks the experts for the State sat and listened for points, and nightly wrestled with hydraulic problems. Early morning consultations with the attorneys developed the method and line of cross-examinations. During the progress of the case it was clearly brought out by the cross-examination of the opposing witnesses that there were other methods of controlling the flood flow aside from the costly construction which they assumed would be necessary above Dam No. 1, and which would enable the State to leave the heighth of Dam No. 1 at the same level as it had existed for the past fifty years and to use the power occasioned thereby.

The alternative method of flood control consisted in the suggestion embodied in the report quoted, that a large amount of flood water could be passed through the head gates of the power plant into the tail race, and thence out into the channel below. This would allow floods to be controlled without raising the level above the ordinary limit in the basin above the dam. It was suggested and admitted during cross-examination that these gates could be made automatic, so that when the floods in the upper basin rose above a certain height they would be thrown into operation to relieve the upper basin of its accumulated flood water and pass it out through the tail race.

Upon the conclusion of this testimony on the part of the Sanitary District's experts the State rested its case without producing any witnesses, and sent its experts home without having testified, and the decision rendered in the case justified their action, for the court held with the State Commissioners on nearly every point, refusing to recognize the right of the Sanitary District to lower the crest of the dam, which had been in existence at a fixed height for nearly fifty years.

Upon the conclusion of the case and the rendering of this decision, it fell to the lot of the author's firm to readjust the plans in accordance with the Court order. A tail race was designed 75 feet in width over 1,000 feet long, and from 15 to 35 feet in depth. It was blasted out of the solid rock. Its entrance way into the river below the dam was effected, not by removing one of the bridge piers as was at first suggested, but by swinging the east end of the dam north until the width of 90 feet was obtained.

The original dam being out of repair, it was cut away and an entirely new dam of Portland cement concrete was constructed in its place with a broad crest at the top. A by-pass tunnel was excavated in the solid rock immediately above the dam, which is able to pass about 30,000 cubic feet of water per minute from the tail race of certain wheels in the Power Company's plant across the river, to feed the Chanahon level of the canal. This arrangement became necessary on account of the slightly higher elevation of the Chanahon level over that which would be produced naturally in the new tail race. A new lock was constructed of Portland cement concrete at the west end of the dam; and the whole power at this spot was developed, so far as machinery, turbines, and headgates were concerned, by the Economy Light & Power Co. which had a lease upon the power at the time the litigation originated, having still about seventeen years to run.

Among other results of this interesting litigation is the fact that much light has since been thrown upon the flow of large volumes of water over different kinds of crests, more especially by the experimental hydraulic work done at the laboratory of the University of the State of New York at Ithaca. The author does not know whether this hydraulic work has been entirely the result of this litigation, but it is certain that much interesting and valuable work has been done along this line, and important conclusions published which were originated by several of the experts employed by the Sanitary District of Chicago at that time.

Aside from a visit to this interesting power development which the author hopes will be taken by the Society, the members will be further interested to see at this point one of the most important and largest installations of electrical development by water power which has been made in this part of the country. This was done by the Economy Light & Power Co. under the direction of their engineer, Mr. Thomas T. Johnston.

REPORT OF THE COMMITTEE ON PAVING BRICK TESTS AND SPECIFICATIONS.

At the meeting of this Society in Bloomington a year ago a standard method of conducting the rattler test for paving brick as recommended by this committee was adopted by the Society and recommended for use. This method is substantially the same as the modified standard adopted by the National Brick Manufacturers' Association in February, 1900. During the past summer a committee of that Association investigated and reaffirmed this standard method, and a committee of the American Society of Municipal Improvements recommended this form of rattler test. The latter society voted to recommend the acceptance of this form as a standard for the rattler test. A summary of the work connected with these actions may be of interest.

It will be remembered that in February, 1900, when the National Brick Manufacturers' Association adopted the new standard (using cast iron shot) they asked their Committee on Technical Investigation to investigate some modified form of rattler which would use the principle of clamping the bricks in place in the machine. The Jones rattler, which clamped the bricks in pockets, had proved to be unsatisfactory. With a view of seeing what could be done along this line, the chairman, aided by Mr. C. V. Seastone, now of Purdue University, designed a rattler in which the bricks were clamped around the circumference of the cylinder, and themselves formed the cylindrical surface on which the blows of the abrasive material fell. The University of Illinois built such a machine, but before it could be tested a fire burned the Laboratory of Applied Mechanics and not only injured the machine, but destroyed all facilities for making brick tests. The machine was rebuilt and in the interim when the University of Illinois was without a testing laboratory, it was sent to Prof. Edward Orton, Jr., the investigator in charge of the work of the National Brick Manufacturers' tests. Prof. Orton made a comprehensive test of the machine, calibrating it and testing five makes of bricks both by the standard method and by the new machine—an elaborate set of tests. The results of his investigations were presented to a conference committee composed of the committee of the Association and several men interested in the testing of paving brick. The advisory committee consisted of Dean J. B. Johnson of Wisconsin State University, Prof. A. Marston of Iowa State College, Prof. W. K. Hatt of Purdue University, and Prof. A. N. Talbot of University of Illinois.

This advisory committee in their report stated that they found that the Talbot-Jones rattler (so-called by Prof. Orton) overcame the mechanical defects of the Jones machine; that it is an efficient tool for testing paving brick; and that it discriminates more sharply between hard and soft brick than does the ordinary rattler, though the same general conclusions were reached. They considered that the Talbot-Jones is more complicated and more difficult to operate and is more expensive; and that the advantages of the process are not sufficient to warrant a change from the simple method already in use. They concluded that the 1900 National Brick Manufacturers' Association standard method of the rattler test is reasonably adequate and satisfactory as a rattler test and recommended a continuance of this standard.

The Committee on Technical Investigation, composed of W. D. Richardson, D. V. Purrington, Anthony Ittner, Charles A. Bloomfield, and Edward Orton, Jr., has since reaffirmed the standard of that Association. They declared their belief that none of the various tests heretofore proposed for determining the strength, hardness, or toughness of burned clay wares compares in efficiency with some form of rattler test; that neither the cross-breaking test, nor the crushing test, nor the specific gravity test represent the conditions of wear in a street with sufficient closeness to make the results convertible into terms of strict wear; and that the standard rattler test has won its right to the public confidence and to general adoption.

The Committee on Brick Paving Specifications of the American Society of Municipal Improvements recommended a method for the standard rattler test practically the same as adopted by this Society, except that duplicate tests were specified. It was explicitly stated that the recommendations for a standard method was not to be held as advocating the exclusion of other tests, or as claiming the adequacy of the rattler test as a criterion of the quality of paving brick. Properly conducted, this test gives evidence concerning the wearing properties of the brick and as such it is entitled to weight in forming a judgment on the brick.

The greatest obstacle in the way of testing paving brick is the lack of uniformity in the brick. That the great diversity in results of tests it due almost exclusively to variations in the brick themselves is shown by the results of the tests with the Talbot-Jones machine. The tests of brick furnished for pavement is further complicated by the variations found in the methods of selecting sample bricks. As brick are now furnished for streets, great diversity of results of tests must be expected, and likewise great diversity in the wear of the pavements. Great care must be exercised in the selection of samples, and some fair method devised which will show the manufacturer the desirability of furnishing a product much nearer uniform than is common at the present time.

The investigation with the Talbot-Jones machine, in which the wear is somewhat similar to that in the street, is of service in showing that the results of the ordinary rattler are likewise indicative of the wear in the street and hence tend to give more confidence in its results. The new machine promises to be of service in general investigation, as, for instance, in tests which may be made upon brick which has seen service in the street. It is possible that with modifications of speed and kind of wear, this machine may yet be made the most acceptable method of testing.

Your committee sees no reason to change the recommendation made last year concerning the rattler test. While not by any means ideal, and while not always closely discriminating, the standard adopted when carefuly followed gives valuable evidence on the wearing qualities of brick. The use of the rattler test is not to be held as the only test desirable, and it is believed that further investigations of the absorption and cross-breaking tests will make it feasible to use these methods much more satisfactorily than our present knowledge allows.

The chairman of the committee feels that little additional data on the advisability of the use of the absorption test and the cross-breaking test is likely to be available soon and that little of value can be given beyond what has been given in previous reports. With the adoption of a standard method of conducting the rattler test, using a standard amount of a standard form of cast iron shot, the committee feels that the Society has achieved a result which will prove to be advantageous to brick pavements. When further developments make it seem feasible to change the standard metohd or to settle other matters, it will be well to give work to a similar committee. For the present, however, it does not seem wise to continue the committee and it is accordingly recommended that the committee be discharged.

A. N. TALBOT,
Chairman.

DISCUSSION.

PROF. A. N. TALBOT: The new testing machine described in the report has a diameter the same as that of the standard machine of the National Brick Manufacturers' Association, 28 inches. It was intended originally to have a wooden center upon which the brick might be placed so that the inside diameter would always be the same regardless of the depth of the brick, but as there is so little variation in the thickness of the brick this was thought unnecessary.

The Advisory Committee of the National Brick Manufacturers' Association made more of the matter of cost of this machine than was warranted. The difference in the cost of this machine and that of the ordinary rattler is not more than five or ten dollars. Of course there is an additional cost of keeping the machine in repair, because there is a great strain on the bolts. These bolts must be screwed up very tight as there is a great deal of pounding and wear on them. The speaker believes that the whole machine can be built for $75.00.

The question of the limit of absorption to be placed on the brick was not considered by this committee which met at Columbus. It was called to consider the rattler test only. The whole attitude of the National Brick Manufacturers' Association has been against the absorption test. However, some of the members of the committee now admit that it may be possible to use the absorption test if specific requirements are made for each make of brick or brick made in a particular territory. This is along the line suggested to the Society a year ago. In some brick the limit of absorption may be as low as two per cent, while in others it may be as much as four or even six or seven per cent. No general statement can be made in regard to this. Some brick made in Ohio and the shale brick of Indiana give very good wearing qualities when the limit of absorption is higher than four per cent.

MR. H. E. BEASLEY: In Peoria the limit of absorption is placed at two per cent, but the speaker has allowed some latitude during the last year so that it will average nearly three per cent, or possibly more. However, he has found that the brick with the higher limit of absorption grind off more and they would show up as softer brick in a rattler test.

There is one street in the city which will be very interesting to watch. One half of the street is laid with brick in which the absorption is one per cent or under, and the other with brick having an absorption of three or four per cent. This street was paved three or four years ago, but the speaker has not yet been able to obtain any information in regard to the results.

The speaker understands that the City of St. Louis has adopted a limit of absorption of two per cent. This does not seem correct, because it is not possible to state one limit of absorption for all classes of material. Four per cent seems too high a limit to the speaker; it surely should never be allowed for such brick as have been tested in Peoria.

Brick made in the last few years do not seem to be as good as those made six or eight years ago. Pavements laid in 1894 show no more wear than those laid two years ago. Repressing also does not improve the brick.

MR. J. C. QUADE: The speaker agrees with Mr. Beasley that four per cent is too high a limit for absorption. There is certainly in general a relation between the absorption and the abrasion. Furthermore if there should happen to be no tests on a certain kind of brick it would be impossible to specify what limit of absorption should be specified for them. So that in general it seems that it is not well to adopt too high a general limit for absorption.

PRACTICAL MUNICIPAL RESURVEYS.

BY W. M. HAY.

One of the most important questions confronting the practicing surveyor and city engineer is the proper location of street and property lines in our cities and villages. The question is very frequently not an easy one, and will require more careful attention as years go by. Land marks and stones which at one time were true evidences of old original surveys are lost, displaced, or removed. In the public highways the heavy road graders and other highway implements handled by persons ignorant of these old land marks do much to destroy their location. Along street and lot lines the construction of buildings, sidewalks, and fences with the necessary grading and post hole excavations have many times caused the removal of the old stake, the stone, or other evidence of the true location of lot and street lines; and now, in these later days, when division and street line fences are no longer regarded as necessary to hold the great majority of our law abiding citizens within bounds, even the evidence that they heretofore have furnished vanishes with their removal.

With all such causes operating to destroy the exact location of these old land marks there arise effects which should call for earnest consideration by every community. It is but natural that property line disputes should become more frequent between individuals and between the individual and the public as the old evidences of the true location of such lines become more uncertain and indistinct. There are always people in every community looking for trouble. A simple dispute upon some trivial proposition between neighboring lot owners, or between a lot owner and the municipality, often leads to expensive litigation concerning the exact location of lot and street lines. In all cities and villages legal entanglements over street lines are likely at any time to develop where such lines are in doubt. The cause of doubt and uncertainty regarding street lines arises primarily from a lack of sufficient permanent land marks to properly perpetuate such lines. If all block corners were properly preserved by permanent monuments which the public could see, no doubt or trouble would ever arise over the question of street lines, and when the true location of street lines is settled, the question regarding lot lines certainly is not a very difficult matter to adjust.

Municipal corporations are the only agencies to successfully cope with the question of proper relocation of street lines; and it is certainly to their interests to cause such resurveys to be made as will establish permanently and without question all street lines by permanent monuments at the block corners. Not only is it to the peace and welfare of the community to do this work to prevent future litigation, but it proves an ever present asset to the municipality. The permanent block corners become a guide from which to work in the construction of permanent improvements upon the public streets. All sidewalks, curbing, guttering, parking, grading, sewering, water-piping, and paving can then be made in perfect harmony with the street lines by simple measurements from such block corners. It frequently happens, however, that a neglect of such considerations often makes an eye-sore of an otherwise well improved and beautiful street. If one takes note of the zigzag and wandering sidewalks sometimes found along the street lines of many of our cities and villages this fact will impress itself forcibly upon his mind. Yet these improvements when of a permanent nature remain for years to disfigure the appearance of the street, unless the municipality takes upon itself the expensive task of properly alining the improvement. The extensive use of cement in sidewalk construction of late years has given a great impetus to permanent sidewalk construction in the smaller cities and villages of the State. Many of them have begun the work by having all street lines properly surveyed and permanently defined so that the sidewalk improvement could be placed properly with reference to the street lines.

It devolves upon the surveyor, when called upon to make municipal resurveys, to execute them in a careful and intelligent manner. His data as taken from officially recorded plats is of course his main guide in the investigation of the conditions on the ground. Yet this data must be investigated to ascertain the accuracy with which the work was done. The plats should be carefully examined to ascertain if all measurements are consistent with each other. Each plat should be considered by itself, for much perplexity may be caused by endeavoring to harmonize the lines and bearings in two separate additions when the original surveys did not harmonize, even though the plats show them in harmony with each other. Another proposition which should be investigated at this time is the individual accuracy or "factor of safety" of the original surveyor. This may have an important bearing upon the field work. We must, however, remember that much of the subdivision work of years ago was done with instruments less accurate and with measuring appliances more likely to be in error than those of the present time. It is also to be borne in mind that many "original town" plats of the early days were made when the land was cheap and that much less effort and time were expended for the sake of accuracy than at present when land is much more valuable. The surveyor has to contend therefore with the inaccuracies of the older surveys due to such causes as above mentioned; yet, having discovered these inaccuracies by means of better instruments and more time to make his work accurate, he is better enabled to harmonize his work with the original survey. The question, as Judge Cooley aptly presents it is, "Not how an entirely accurate survey would locate such lines, but how the original stakes located them."

The execution of the preliminary field work of a resurvey should consist of careful and accurate measurements from base lines to all topographical data that would tend to show the location of boundary and divisional lines in the subdivision. The topography which concerns the surveyor consists chiefly of old landmarks, corner stones, iron pins, old line stakes, fences, sidewalk lines, and, where closely built up, party wall or building lines. A quadrilateral or parallelogram of base lines should first be laid down upon the ground. Such base lines can generally be laid down in the streets or alleys and should be made as nearly parallel as possible to existing street lines. Where they intersect the apparent street lines of intersecting streets temporary marks should be made, generally a nail or spike driven in the ground will suffice. These base lines should be measured very accurately, the degree of accuracy, however, depending upon the value of improvements and the compactness of the buildings upon the land. Duplicate measurements should check within the limits of the formula:

$$E = .003 \text{ feet} \sqrt{\text{Length in feet}}$$

where "E" is the allowable difference between measurements. The constant .003 feet may be increased to .004 or .005, or even more, if the conditions do not justify this accuracy. The angles which the base lines form with each other should be determined by taking the average of at least four measurements taken at different portions of the limb of the transit. The angles should be measured to half minutes or less if possible. From the temporary marks along the base lines measurements can now be made along the street lines to the topographical data which has any bearing upon the problem.

The measurements should be continuous, each denoting distance from the base line. The measurement between the sides of the quadrilateral of base lines is finally determined along the street lines and if the results check with computed results within the limits of the above formula no re-measurements are necessary. Otherwise the work should be again measured to bring the results within limits.

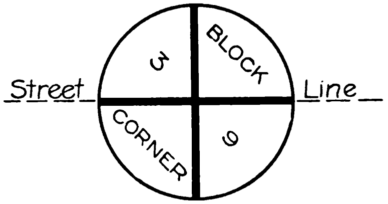
The field book record should be kept clear and distinct. Full notes and explanations should be made when necessary. Brief notes of statements from old landowners should be recorded. Some objects along the line may appear to be of unusual importance, others indistinct and misleading. When the measurements are completed and recorded, the surveyor is able to tabulate his work for convenience of comparison of measurements on the different streets. A careful study of these comparative measurements will disclose to the experienced surveyor a true solution of location of street lines. Every effort should be made to outline a plan of re-survey which will harmonize most completely with the evidence on the ground as shown by the tabulated notes, yet due consideration must be accorded to the facts as represented by the plat. The proposition of surplus or deficiency must be carefully investigated.

Errors in plats, variations in bearings, and length of chains are fruitful sources of trouble along this line. If the ground be undulating and the original survey not carefully made, a deficiency might have existed in parts of the subdivision; while in other parts more level there may have been even a surplus. The general aim should be to give to each block its recorded measurement if possible and to allow for such surplus as may be necessary to produce results in harmony with the original survey. The streets and alleys should be made the exact width on record without surplus. The reason for this is that improvements made on public thoroughfares are generally made with reference to street or alley lines and if a surplus or deficiency of width existed confusion might result. There is also the assurance that if the municipal authorities can get what the plat allows them for streets and alleys they are content to let "well enough" alone. The general aim of the surveyor should be to harmonize the street and alley lines with the original plat so far as width and alinement are concerned. He must be ever mindful of the well established principles of law relating to the rights of municipalities in the possession of the streets, and not to confuse such principles with others relating to established rights as between private owners of real property.

After the surveyor has faithfully investigated all the data, circumstances, and conditions; and he has reached satisfactory conclusions regarding the location of the lines of a re-survey, his next duty is to locate permanently such lines upon the ground. However, there may be circumstances and conditions existing under which no satisfactory conclusions can be reached. In such cases competent legal advice should be sought and also in all cases where lines are in controversy. The execution of the work of location of the lines of a re-survey, after having made the accurate preliminary measurements and determined upon the precise location, is a matter which a surveyor can easily work out in his own way. The center lines of the streets can be first measured out from the base lines, and when such lines are all run and properly marked out, the block corners can be easily located by simple measurements from such lines. For temporary block corners a small stake with a tack in it will generally suffice until the permanent corner is located. It is well to set reference points at this time by marks on the ground or sidewalks at certain distances from the block corner to be used when the permanent corners are located.

For permanent marks natural stones of all kinds and descriptions have been most commonly used. The appearance of such monuments when left above the ground surface is, however, sometimes found objectionable and at times an obstacle in the way of improvements. When set below the surface, the marks are hidden and much of the force of the use of the monuments is lost. Concrete properly prepared and placed in a hole excavated at the corner has proved a good substitute for natural stone. Before the concrete has set, however, a copper bolt or nail should be inserted vertically in the mass of concrete at the exact corner. In constructing a concrete corner the temporary stake should be first removed and a hole about two feet in depth dug with a post hole digger. This tool will make a circular hole six inches in diameter or larger. When excavated to the proper depth the concrete should be deposited through a large funnel into the hole in order to prevent dirt dropping into the concrete from the sides or top of the hole. When properly tamped and filled with concrete, the surface should be finished off with neat cement mortar one-half inch thick and the copper bolt inserted as indicated above, using the reference points to find the exact location of the corner. Two brass impressions, one bearing the word "Block" and the other "Corner," can then be impressed into this neat cement surface; the word "Block" is placed above the copper bolt and the word "Corner" below it. At either side of the bolt the block number can be stamped. Separate brass impressions from 0 to 9 will be necessary to make the various combinations of figures for the block corners. By this means the monument not only consists of concrete to perpetuate the corner and a copper bolt to designate the exact corner, but it also tells upon its face the name of the corner and the number of the block which it bounds. The cost of an outfit of impressions, such as above described, is about four dollars. The impressions must be made specially for cement work. Printers' metal type are very poor substitutes.

Although it might at first appear that concrete used for permanent corners in this manner is better than stone in all cases, there are some communities in which this plan cannot be profitably used unless a policeman stands guard at every corner to keep the mischievous small boy from mutilating the surface before the concrete has properly set. In such cases and where the corners are to be set at some established grade it is better to make the corners in a sewer pipe and allow them to set before placing them in the ground. The making of a corner in a sewer pipe permits of a much neater and more symmetrical job. The exact corner can be made coincident with the axis of the pipe, but it is difficult to dig the hole exactly centering on the corner so that the copper bolt will be in the center of the concrete surface. To construct a "block corner" by use of sewer pipe and concrete, the pipe is set on end bell up and filled with concrete. Usually four-inch sewer pipe will suffice. After the neat surface coating has been applied and a convex surface given to the top with the center about one-eighth inch higher than the edge of the finished surface, a surveyor's tally pin is drawn horizontally across the cement mortar surface in two directions at right angles to each other forming a cross with the point of intersection in the center of this circular surface. The mortar surface may need some slight trowelling a second time to smooth down any loose particles of mortar, and possibly the pin must be drawn across the surface again to secure the proper neat appearance of the finished surface. The "block corner" and block number impressions can then be brought into use and the impressions made in the manner indicated by the cut below:



The cut shows the proper arrangement of the surface with reference to the block corner when the monument is set in the ground. In setting the monument enough space should be excavated to allow for proper tamping and wetting of the filling to secure solidity of the soil around the pipe. If the monument is in a position where it may be subject to subsequent disturbance, the entire hole excavated should be filled with concrete. If traffic is likely to do harm the monument should be made in the bell end of a four-inch cast iron water pipe and set in a solid bed of concrete. A copper bolt should be inserted into the concrete in the water pipe at the exact intersection of the cross so that in the event of the concrete surface wearing away the copper bolt would still give the location of the corner.

The cost of the making and setting of these permanent monuments above the cost of the ordinary stakes is, for ordinary work, about seventy-five cents per corner.

Monuments, such as above described, should be set at every block corner where it is possible to set them. A combination of the two methods will be necessary in extensive work as there will be found locations at which the monument must be built on the ground. To make the work complete the monuments should be set at the sidewalk grade. Where permanent walks are laid, the surface of the walk and monument will be at the same elevation. Where no walks exist, or where they are of a temporary character, the monuments should be set at the established grade for permanent sidewalk construction. By this means the municipality not only secures the permanent location of the block corners, but also the permanent grade marks from which to proceed in the construction of permanent sidewalks or other street improvements. For the smaller cities and villages, where the services of an engineer are not always at command, this plan is well adapted; and it will be found in after years to have been a wise consideration, as it settles the troublesome grade question which so often confuses the average citizen. It also makes plain to every one the exact grades at all street intersections. This feature alone should commend itself very forcibly to the lot owner, as it becomes a guide to him in the grading of his premises and improvement of his property.

When all block corners and other necessary points have been perpetuated by permanent marks, the next and final work, where there are variations from the original plat, is to make a plat of the re-survey. This plat should show the street and alley lines with the exact distances between the permanent monuments on these lines at street or alley intersections. The angles which intersecting streets form should be designated and all data given which will be a guide to surveys in the future. Lot lines should be omitted, except in rare instances, as the object of the re-survey is to locate the old original street and alley lines. The surveyor's certificate and the municipality's authorization and acceptance of the work and plat should appear upon the plat before it is officially recorded.

With the final act of recording the plat the work of the re-survey is completed, yet at this moment an opportunity offers itself to the municipality which, if properly executed, will prove of much importance. Nearly every municipality is in need of an accurate plat of its streets on an enlarged scale to properly plat and designate the public improvements under the surface of the streets, and to show their location with reference to the street lines. A municipal plat book could be easily inaugurated at this time and contain the data of the re-survey together with all other data regarding sub-surface improvements which can be gathered and platted. This plat book can be made to any practical scale, the pages being more or less numerous according to the scale. Such a book would be extremely valuable in a few years if all improvements were recorded on it as made, as it would show to future municipal officials where past improvements were made and guide them in the location of new improvements.

In conclusion, it may be said that practical municipal re-surveys can only be made true to name by practical methods which will stand the tests of law and time. The surveyor must thoroughly know his business and the law as it appertains to his work. Decisions of the courts must be studied and their directions applied. Abstract theoretical notions as to what the original surveyor should have done are not to be considered. What he did actually do must be ascertained by earnest and diligent effort guided by the use of accurate methods and instruments. What the present and future generations desire to know are the facts which were of common knowlecge to the original owners of their property, but which have become obscured by the decay or removal of the original land marks. No municipal re-survey can be considered complete which does not define and perpetuate the original street or block corners by permanent land marks.

DISCUSSION.

MR. H. G. PADDOCK: The speaker notes that the monuments described by Mr. Hay are only two feet deep. It occurs to him that these might heave from frost, and that it would not be advisable to use them to give elevations. In four or five years they might work up out of the ground so much that any sidewalk or other grade set from them would be too much in error.

It is well to bear in mind that each locality has its peculiarities and methods and devices must be modified. In Moline the speaker has used seven-eights inch iron rods three feet long set at each block corner. These serve very well. They are substantial, for it will take considerable force to pull a rod out after it has been in the ground six months. They are also cheap, costing about twenty-two cents at the present prices of iron, which is very high. The rod is also much smaller than the concrete monument and it is possible for a property owner to set a fence or wall to take in all his ground without interfering with the monument.

If only one monument is set at street intersections it is very liable to be disturbed by excavations or street improvements. If four monuments are used they are not so likely to be tampered with, and if one is disturbed it can easily be discovered by checking on the others.

There are some intricate questions in connection with the "factor of safety of the original surveyor." The speaker remembers a subdivision about two blocks long which had a street running through the middle. This street was in a ravine about thirty or forty feet below the general level. There was a deficiency of six feet in the two blocks. Now one is morally certain that this error was made in crossing the ravine. According to theory it should be pro-rated, but it is certain that this will not reproduce the original conditions.

MR. W. M. HAY: The effect of heaving from frost would not be enough to make any material difference; a little variation will be of no moment as far as sidewalk grades are concerned. The speaker has not made any observations in this direction but intends to do so.

If four monuments are used at street intersections the street lines are very definitely defined. Sidewalks may be located from them so that they are perfectly straight from one end of the street to the other if the street is straight.

There is always liable to be some question as to the exact point if stakes or iron pins are used. This can not occur with the monuments used by the speaker. In one case in the speaker's practice he found iron pins driven alongside the original stakes, which surely will lead to confusion.

In general the street lines are to be made straight from one end of a subdivision to the other; but the surveyor must be guided by the old land marks. If it is found that some of the monuments are out of line and the street and property lines correspond with them they should be made to govern if possible. The surveyor can not disturb all the street lines; he must find out which of the monuments are correct, and then use his judgment in making the street lines conform as nearly as possible to the lines determined by them.

The right of possession by occupancy enters into this matter only in exceptional cases. The Statute of Limitations does not hold against a municipality in the matter of street lines, except when a person has erected a building of such a permanent character that it would involve him in a great pecuniary loss to remove it. An ordinary fence will never give a property owner title to land in a street.

In a re-survey all lines are placed where they were originally except where a person has infringed upon his neighbor for a long enough time to obtain title by adverse possession.

MR. J. L. CLARK: It is not always possible to set monuments at grade. In Los Angeles and Kansas City, for example, the grade is twenty feet above the natural surface in some places.

The speaker has used monuments made of three-inch gas pipe four feet long, filled with concrete. The pipe rusts out in a short time but the concrete remains firm.

Monuments on a street do not often line up and it is usually a difficult matter to get a street line. It is the speaker's practice in giving sidewalk lines to construct a line from one end of the street to the other. This makes the sidewalks straight.

The speaker once had a case which brought out question in the matter of pro-rating errors. A street was put on the plat of a subdivision and by an oversight the width of the lot from which the street was taken was not changed. The street was 66 feet wide, making the length of the subdivision 66 feet in error. The question now arises as to how this deficiency is to be divided; according to theory it must be pro-rated, yet this is grossly in error. There is nothing to actually prove that this error was made, but it is quite evident that it was. No question was raised about this until it was desired to put in improvements. Property owners had been pretty well agreed on their lines. The speaker spent several days in looking the matter up, but found nothing that would agree with the plat. There seemed nothing else to do but to take the lines as they were on the ground.

MR. B. J. ASHLEY: In recent years the speaker has set one monument in the street intersections instead of four. These monuments are seven-eights inch rods driven so that they stand about six inches above the ground in order that they may be found easily. Just what will be done when the streets are improved the speaker has not decided, but the top will probably be protected by concrete.

If monuments are set at the block corners they are also quite likely to be disturbed. About the first thing that a property owner will do when he sets his fence is to disturb the monument. With the present practice of the speaker there is not much danger of disturbance of the monuments in the street intersections, for he is making a practice of placing underground conduits in the alleys.

MR. J. W. ALVORD: Some years ago the speaker undertook a job of surveying in a small city in Illinois. He had considerable trouble in distributing this "factor of safety," as Mr. Hay terms it. One subdivision seemed to have a "factor of safety" of about half a chain, and when it was platted it looked considerably squashed. A number of very interesting examples of this occurred throughout the piece of work and caused the speaker many sleepless nights.

The important question in this matter is that of providing for this "factor of safety" of the original surveyor, especially where the property owners have obtained title by adverse possession and cannot be disposessed by any legal means and will not be disposessed by any other means.

MR. EMIL RUDOLPH: In regard to the action of frost on monuments it might be said that it has been the speaker's experience that stakes sixteen or eighteen inches long will not be affected by the frost if driven flush with the ground; but if they are left an inch or two above the surface they will work out in three or four years. In view of this experience the speaker thinks that it would be best to make concrete monuments four feet long instead of two.

ONE OF THE OBJECTIONS THAT HELPED DEFEAT THE SURVEYOR LICENSE BILL.

BY W. P. FEENEY.

The author being interested with other surveyors to know the reason why the bill for the licensing of surveyors of this State which was presented to the State Legislature at its last session was defeated, called upon several of the Chicago members of the Legislature. These gentlemen had previously been asked to support the bill and they had taken an active part in discussing the bill with members of the Legislature who were opposed to it. The members stated that there were a number of objections and that only one appeared to have any foundation. This objection was that the bill as presented would not benefit anyone. It afforded no protection to the property owner from the fact that it would have allowed any surveyor who had passed the required examination to send out in the field to make surveys his rodman, chainman, officeman, or typewriter; in fact, anybody he chose to send. He could then sign the plat of the survey representing to the owner that the survey was made by an Illinois licensed surveyor.

This objection is worthy of consideration by this Society, for there is no doubt but what this condition of affairs exists. The writer personally knows of several cases of this kind. One instance where one of the leading surveyors of Chicago employed an instrumentman who was out of work and called into the surveyor's office looking for something to do. He was known to the surveyor as being a good instrumentman and was in the habit of receiving three or four dollars a day for his services. He was informed that there was a small job to do which consisted of subdividing a block, the corners of which were already set, and that if he wanted to go out and act as chainman at $1.50 per day, he could get in the day; that he was sorry he could not do better by him, as he had a surveyor in the office whom he would send out to do the work. The instrumentman said that he would go and act as chainman.

When they reached the ground the chainman set ranges at the block corners and spread the stakes along on the lines, and the surveyor set the transit over a stake at one of the block corners and leveled it up. They then chained one of the lines setting stakes the proper distance apart and lining them in as well as they could by the eye. When they reached the end of the line the surveyor said he would go back to the transit and give line. He cautioned the chainman to be very careful in driving the stakes as he wanted good work done, because they were subdividing valuable property and not land in the country, and that if he expected to go out with him any more he would have to show that he was a first-class chainman. After giving this advice the surveyor went back to the transit and began looking through it, then pulled out his handkerchief and wiped the object glass, looked again and did some more wiping; and, after fooling around for fifteen or twenty minutes, he called his chainman up and told him they would have to go back to the office. The very thing he had been expecting had happened; the instrument was used the day before in all the rain and the cross hairs were washed out of it. Of course the chainman did not feel disposed to offer any information to a man who had been lording it over him, and the result was that they went back to the office. When the surveyor asked the man he had sent out in charge as to what was the matter, he was told that the cross hairs had been washed out of the transit and that they could not run any lines. Then the surveyor set up the transit and after adjusting the eye piece brought the cross hairs into view and then turned on the chainman and commenced to rake him over the coals for not finding the cross hairs for the surveyor. Of course the chainman told him that he went out as a chainman and that if he had paid him to take charge and do the work it would have been done, but that under the circumstances he did not feel disposed to do more than he was hired for. It developed that the man who had been sent out in charge of the work had only one month's experience and that the surveyor was aware of it and was only paying him $9 per week. This surveyor afterwards told this story to other surveyors with the purpose of injuring the instrumentman, stating to them that a man that would do a trick like that should not be employed by anyone. He was informed by some of them that the best thing for him to do in the future, when he had more work than he could do, was to pay decent wages and he would get someone that understood surveying.

In another case a surveyor, who claims to rank with the leading surveyors of Chicago, made a large subdivision in the northwestern part of Cook County. He employed as chainmen two country boys who never had any experience; and, after showing them how to hold the chain and to read it, he taught one of them how to set up the transit and sight through it, and in the course of two or three weeks he had his plat made and the block corners set. Other work called him away and he left his transit with the boys and told them to go ahead and stake out the lots and make them the same as the plat showed, which they did. Some time afterwards when making a survey in that part of the county, the author's attention was called to this survey by hearing the two boys speak about it. They told him how they had surveyed and subdivided 160 acres into lots; that in three weeks they had become surveyors; and that there was nothing in surveying but to look through the transit and to know how to read a chain. Shortly after this the author was surprised to hear the surveyor himself telling how he had taught two green boys to run a transit and chain in so short a time, and how he was able to leave the work in their hands to finish. He was asked if he had checked their work and he said no, that he was satisfied that it was all right.

There are surveyors in Chicago who have in their employ men that could not pass the simplest kind of an examination. They receive $40 to $50 per month as rodmen and chainmen, and when orders come into their offices fáster than the regular surveying parties can handle them, new parties are made up and the $40 or $50 per month chainmen sent out in charge of them. The surveyors that make a practice of doing this say they have a right to do so, as they are assuming the responsibility and if there is any mistake made they will have to stand for it. Is this justice to they property owner who comes in good faith to a surveyor whom he knows, or has heard of by reputation to be a careful and competent man, and expects to get a survey that will be made by a man throughly posted in his profession?

This idea of sitting in your office and telling your chainman what you found years ago in this block or that block and to chain so far from this fence or this building and drive stakes for his lot lines, is all right sometimes; but there are certainly times when it it *not* all right. It would be better for the surveyor, the property owner, and everybody else if a competent surveyor had been sent out who would check up the previous work and also investigate and find out how the new surveys in that block made by other surveyors agreed; and if there is a difference, find the reason and catch any mistake in time. What opinion does the educated man in some other profession have of the surveyors in general when he sees a man in charge of a party making a survey who he knows is not capable of doing long division?

The foregoing remarks are made by the author purely in the interest of the surveying profession and with the hope that the next bill presented to the State Legislature will contain a clause that will do away with the objection stated.

DISCUSSION.

PRES. H. G. PADDOCK: The bill as presented to the Legislature was a compilation of two bills, one prepared by Mr. Greeley and one by the speaker. This was done in order that all the ideas might be embodied. The bill was then put into the hands of Senators Juul and Johnson. Senator Juul went through the bill and made several suggestions which were adopted and all suggestions made by any Member were thoroughly considered.

The speaker never heard the objection alluded to by Mr. Feeney, and he talked to more than a hundred Members of the Legislature. He feels sure that if this objection had been made to the bill it would certainly have been amended. As to the correctness of the contention of Mr. Feeney, the speaker wishes to say that he surely will not favor any bill hereafter upon which any such construction can be put. He believes that the person in charge of a surveying party should be a licensed surveyor.

It is a fact that unless a bill can be presented which will be free from objections by Chicago surveyors and in fact from all but County Surveyors it will be useless to attempt to pass it through the Legislature.

MR. W. P. FEENEY: This question of licensing surveyors was discussed before the bill reached Chicago. At that time some of the Chicago surveyors were opposed to all kinds of bills. They used the objection referred to in the paper. They used it with good effect upon the Members of the Legislature whom they could influence. The speaker knows personally two Members of the Lenislature who were opposed to the bill simply on these grounds, and if it had ever reached the House they would have voted against it. There is no Chicago surveyor who was seen by the speaker who would not say that the bill was defeated because it had this one objectionable feature; however, they themselves were not opposed to the bill as it stood.

The object which the speaker had in bringing this matter before the Society was to insure that the next bill brought before the Legislature will not be open to this objection. He is in favor of any bill because it will be sure to be beneficial, but there is no reason why all objectionable features can not be taken care of.

It might be well for the Society to go on record recommending a bill that will contain a clause which will prevent people from employing incompetent men, knowing them to be such. That something of this kind is necessary is certain. There is a case on record in the recorder's office in Chicago which shows that a man, considered a prominent surveyor of Chicago and who was afterwards elected County Surveyor, subdivided 160 acres and made the mistake of having sixteen lots too many. The excuse he made was that he did not make the mistake himself but that his boy made the survey. The property owner was out the expense of employing a competent surveyor to go over the work to correct the mistakes.

PROF. M. S. KETCHUM: The present Architects' License Law is open to exactly the same objection. Any licensed architect can have all his work done by his subordinates. He need not even see the work; all that is necessary is that he put his stamp on the plans. The speaker does not see but that it is going to be hard to pass a law that will not allow a surveyor to have his work done by subordinates who are not licensed.

As far as the Society is concerned it seems to the speaker that it should take action to drop the matter or appoint a committee to watch the developments.

MR. S. S. GREELEY: The clause which the author seems to object to is Art. VII, Sec. 5.* The speaker does not see how it is possible to prevent a man from employing skilled assistants. If he is foolish enough to employ unskilled assistants the public will soon find it out and his practice leaves him. There is nothing in the law to prevent an assistant of a surveyor from becoming a licensed surveyor. It is endeavored to have them so. The gist of the whole paper seems to be that there are two dishonest surveyors in Chicago. There will be dishonest men even if a bill is passed. It is impossible to do else than to legislate against thieves.

The position which the speaker is beginning to take after nearly forty years of effort to get these bills through is this: The whole surveying business in Illinois is a very small affair; very few persons are interested in it besides the surveyors themselves. The only persons who have been active in trying to get a bill of this kind through are the surveyors, principally the Chicago surveyors, and they are few, there being only thirty or thirty-two offices in that City. The only decided aid given was by the Real Estate Board of Chicago last year. They gave the movement a very friendly endorsement but could not give any aid at Springfield because they were taken up with their own matters. Some fifteen or twenty years ago this Society was started as a Surveyors' and Engineers' Society. It has now practically ceased to be a Surveyors' Society because very important and very pressing problems of Engineering have come up, and the whole interest is very properly centered upon those questions rather than upon the trifling problems of Surveying. Therefore the speaker does not think that it is incumbent upon the Society to make any further efforts to have a bill of this kind passed. The only thing that ought to be done is to watch for hostile legislation. Every once in awhile someone brings up a bill providing that no survey shall be made except by County Surveyors, or something that looks much that way. If the competent surveyors are left alone the matter will probably work out by itself. The surveyors cannot expect to do much, both because of the division among them and the smallness of their number.

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*See Sixteenth Annual Report, page 18.

There is a very great effort to get rid of the useless office of County Surveyor. That office will drop of itself and then will be the proper time to take up the matter of licensing surveyors. Action of this kind should, however, come from the outside; from the property-owner. The public seems to be pretty well served as the whole thing stands at present. The competent surveyor can do every single act that the County Surveyor can do with the exception that his plats are not received without personal testimony. The County Surveyor's plat can be introduced as evidence, although this is not generally done unless it is supplemented by the County Surveyor's testimony.

MR. J. C. QUADE: As stated by Mr. Greeley, a man in charge of a large surveying office can not take charge of the work in every survey himself. The speaker is in favor of having the man in charge of a party a licensed surveyor.

MR. J. G. MELLUISH: It is certainly very desirable that the man in charge of a party be a licensed surveyor; however, it must be remembered that in order to get anything through the Legislature everybody will have to be satisfied. The bill must necessarily be a compromise bill and the question upon which the Society ought to decide is whether it will support a compromise, or whether the bill must conform to the Society's views to have its support.

The surveyor is not to be compared with the architect in this matter of license. The architect's work is more or less temporary while the surveyor's work affects title and is carried down. The architect's work is subject to inspection by building inspectors, while the surveyor's work is not checked. The architect's license can not serve as a model for a Surveyors' License Law.

MR. F. C. ROSSITER: A phase of this question which was not touched upon in the paper was discussed to some extent in Chicago. This was in regard to the fact that if the assistant of a surveyor was not a licensed surveyor he would not have much standing as a witness in court. In the cross examination he would be asked if he were a licensed surveyor; if he answered no there would immediately be a question as to his competency as a witness. There is even now often a discussion when a witness is asked if he is the County Surveyor as to his competency as a witness. The speaker would object very strongly to any measure by which his employes would be placed at a disadvantage in court. The Architects' License Law was discussed among the Chicago surveyors and it was thought very objectionable. The bill presented to the Legislature was also not approved of. The speaker himself did not lend it his support.

As was stated, the question before the Society is, shall it support a bill which it believes to be correct or shall it support a compromise bill? It is certain that a bill which conforms to the wishes of the Society will never pass the Legislature. This bill will surely do away with the office of County Surveyor, and if we remember that most of the County Surveyors are politicians it is easily seen that with their efforts they can defeat it. The bill in order to pass the Legislature must be a compromise bill. It is the speaker's opinion that a bill might be drawn up which will have the support of the Chicago surveyors, and it would be well to have something of this kind again brought before the Legislature. However, it should be done slowly and no steps taken which are too radical. Some discussion took place in Chicago as to the advisability of having a bill which was specially applicable to Chicago because the most valuable property in the State is in Chicago. This might serve as a beginning for the whole matter.

The point has been made that bad surveying affects the property owners. Mr. Feeney cited a case in Chicago. The man who had this surveying done was Mr. S. E. Gross, the greatest Chicago real estate man. He at first employed the best surveyors but they charged him too much and he went to the cheaper men. It can be seen from this how he feels about the matter.

PROF. A. N. TALBOT: It seems to the speaker that the point brought out in the paper is covered by Art. I, Sec. 4.* That, perhaps, is not so ideal an arrangement as requiring the chainman or the man in charge of the party to be a licensed surveyor, but it would work out if this bill were enacted into a law and a proper kind of a Board of Examiners appointed. It easily ought to work out so that facts as described would result in the revocation of license.

So far as the general question of the desirability and practicability of the enactment of the law is concerned there is rather wide room for discussion, and we would not be well agreed upon that point. We have to consider the effect of such legislation in other fields of work. The basis upon which such a law as this would be advocated would be the protection of the property owners from having improper surveys made. It cannot be placed on the same ground upon which either the physicians' or the attorney's license, or even the architect's license were based.

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* See Sixteenth Annual Report page 17.

The attorneys' license of course is good because there is a regulation of the court in order that the business of the court, public business, may be properly and accurately transacted. The physicians' license and the architects' license, in the same way, are based upon the police powers of the State to protect life and health. The Architects' License Law is not based upon a man's ability to design for appearance, but upon his ability to design for strength and proper sanitation.

The speaker happens just now to be a member of a committee of the American Society of Civil Engineers appointed to investigate whether it would be feasible or desirable to consider the matter of license in the Engineering Profession in general. Whether it would be practicable and desirable to weed out incompetents by some form of license or other method. It can be seen that this brings up even greater difficulties than is the case with surveying because the Engineering profession is so broad, covering as it does, the various lines of Mechanical Engineering, Bridge Engineering, Sanitary Engineering, and other fields. Any examination which would be common to all must necessarily be very elementary. The only other way out of the difficulty would be the division into classes and in making examinations in these various classes. There again, many men are practicing on the line of two great divisions and it would be necessary for them to have a license in each of these different fields. As was said, this committee is investigating this matter and the speaker does not know what their report will be, but it can be judged what obstacles are in the way of carrying out any scheme of this kind, and the speaker for one does not see upon what basis it could be put.

So far as the bill for licensing surveyors is concerned the speaker feels that while it would greatly benefit property owners, yet it seems to him that in view of the almost certain action of the

Legislature in turning it down and other difficulties in the way, Mr. Greeley's recommendation that the matter be dropped is the best one for the Society to follow.

MR. B. J. ASHLEY: This Society has spent a good deal of time and effort on the question of licensing surveyors and if the matter is dropped all this is lost. If it has been found that some things are not acceptable to the Legislature, now is the best time to change them. The personnel of the Legislature certainly changes every year, but some of the members will again be there next year and the matter will be fresh with them. If the objectionable features are removed they will likely give their support. If a bill is passed which turns out to have objectionable features it can easily be amended.

In this connection it might be well to consider the question of holding the next meeting at Springfield, so that the members may come in contact with the members of the Legislature and exert what influence they can.

MR. W. M. HAY: This matter ought to be discussed on the broad foundation of the benefit it would be to the property owners. The Society must attack it in this way if it expects to get anything through the Legislature. A bill must be produced which will not affect the competent surveyors either way but will be of great benefit to the property owner. With this idea uppermost in our minds we can expect to do something.

REPORT OF COMMITTEE ON SURVEYORS' LICENSE LEGISLATION.

Your Committee on Surveyors' License Legislation used its best efforts to secure the passage of the Surveyors' License Bill as endorsed by the Society in connection with the Chicago Surveyors' Club. Our Vice-President, Mr. Rudolph of the Chicago Surveyors' Club, did everything in his power to further the passage of the bill by going to Springfield at any and all times when it seemed that there was anything to be gained by so doing and also by having personal interviews in Chicago with Cook County members.

One of the duties of the Legislature was to redistrict the State, which was a particularly difficult matter at this time, occupying the attention of the Legislature to the exclusion of all other business for several weeks. This was followed by the consideration of the appropriation bills. The determination of the Legislature that no other business should be taken up until these matters were disposed of and the unusual uncertainty as to when the Legislature would agree on a settlement of those questions, made it particularly difficult to determine when any given measure would be considered.

The bill was introduced in the Upper House by Senator Juul and in the Lower House by Representative Miller, in conjunction with Representative Johnson, who did everything in their power to secure its passage. The bill was taken up first in the Senate and referred to the Committee on Judicial Department and Practice and by them referred to a sub-committee of that committee. The friends of the measure, believing that this committee was as favorable as any either in the Senate or House, concluded to push it there rather than in the House, particularly as business in the Senate was much further advanced than in the House. We had been to Springfield and looked the ground over somewhat and made, as we supposed, arrangements to be notified whenever the committee was ready to take the matter up, but by a misunderstanding we were not notified in time to get to Springfield until after the sub-committee had had a meeting and decided to recommend an adverse report by their committee. It then became a necessity to persuade in some way this sub-committee to change their mind and recommend to their committee that the bill be reported for passage which finally after a great deal of work, we succeeded in doing. By this time so much of the time of the session had been consumed that the members became very impatient to put the business in the way of completion. Within a session of reasonable length the bill was finally reported by the committee but was defeated in the Senate by three votes.

The bill created a board, thereby giving the Governor additional patronage to which many of the members objected as they claimed he had too much patronage already. Many of them for that and other reasons were in favor of abolishing all of the boards that now existed and of putting the State Institutions under some general commission. There were several bills before the Legislature creating boards for various purposes. This led some of the members to remark that if the Legislature kept on, every line of business in the State would be under the control of a Board. Other members stated that the first Board might be all right, but that they would soon cease to issue the license strictly on merit but would insist that the candidate be a graduate of some one or more favored institutions of learning. Some few claimed that it would create a trust and a monopoly and still others objected to other features of the bill, suggesting a modification. In all such cases as the latter, we informed the Member that we were not ready to say that ours was the best bill that could be prepared on the subject and that all we asked was for the Legislature to take the matter under consideration and pass a bill that in their judgment would best correct the evils of the present system. That the present system was not in the interest of the people, they all seemed willing to acknowledge.

H. G. PADDOCK,
S. S. GREELEY,
W. H. TARRANT.

REPORT OF THE COMMITTEE ON SURVEYING.

The proposed legislation relating to the licensing of land surveyors was placed in charge of a special committee which presents a report upon that subject and make recommendations regarding the same.

The proposed topographical survey of Illinois, discussed at the last meeting, was formulated into a bill and presented to the Legislature. The measure was defeated.

This committee has discussed the question of "Plats" and has suggested that a discussion of this question among the Members of the Society would prove beneficial. This question suggests itself because of the wide differences in the manner of form and outline and in the use of all kinds of paper, scales, and sizes in the make-up of plats of city and village subdivisions. To harmonize, advance, and improve this particular and important branch of the surveyor's work would reflect much credit to the surveying fraternity of this Society. There is no place where the "trade marks" of a surveyor's skill and practice can be displayed to better advantage than in proper, neat, accurate, and complete records of his work as shown by his plats.

Another matter of importance to surveyors and to the owners of real property, especially those in rural districts, is the preservation of the land marks and monuments in the public highways. Every surveyor, who has had occasion to do work in the country or farming districts, no doubt has at times sweat, dug, and searched in vain for land marks supposed to be located in the public highways. The only consolation he gets is the fact that the object of his search is gone. This fact is consoling because it is important. It suggests reflection to the causes operating to remove and destroy the location of such land marks. To those who have given the subject any attention the principal cause is soon evident. To the Commissioners of Highways of the many townships is delegated the duty to grade, improve, and maintain the public highways of the State. Much, or some of this work, has been done by careful overseers mindful of the importance of land marks located in the highways; yet, with the multitude of townships in the State and with thrice as many Commissioners of Highways, it is evident that careless or ignorant persons will be oftentimes elected. Again, Commissioners have been elected who have never given a thought to this question, their attention never having been directed to the matter. The fact of the matter is that Highway Commissioners, in grading the highways, are too often neglectful of this question of land marks which to them should be all important for the reason that such marks designate where the true center line of the highway is located. In these days when many land owners are, or have been, encroaching upon the public highways it is important to know where the true center line is located in order that at some future date the encroachment may not be charged to the land owner who has kept within his bounds. Simple justice to the community, therefore, demands that the Highway Commissioner should know and prevent the causes which have led to the destruction of many land marks in the past. As long as present and past conditions prevail whereby Commissioners of Highways are not sufficiently aroused to the importance of this matter all exposed land marks in the highways will be subject to removal by teamsters and workmen doing grading upon the highways. The strong and powerful road machines which grade and surface the road are also becoming troublesome factors in the elimination of land marks. Many land marks which are gone would have never been disturbed if the persons working upon the public highways had known of their importance or had been cautioned by the Highway Commissioner regarding them.

For the future protection of these land marks this committee believes that the Highway Commissioners must be aroused and enlisted in the matter. If the County Surveyor presents the question to the Board of Supervisors in the proper light he can generally secure enough of an appropriation to have printed and mailed to each Highway Commissioner a circular letter pointing out the importance of the subject to the public and the Commissioners. Such suggestions as will impress, yet not offend him, should be included. A letter of this character from the County Surveyor and authorized by the Board of Supervisors would be respectfully considered and its suggestions and instructions generally followed.

From the standpoint of the Surveyor this matter of land mark elimination and destruction is one fraught with serious consequences; and although it might be to his pecuniary advantage to look at the situation in silence, yet as a public-spirited citizen he should forever raise his voice and hand against all causes which operate to remove and destroy those silent markers of the ground which prevent dispute and litigation.

W. M. HAY,
EMIL RUDOLPH,
L. Z. JONES.

Five copies of the following letter were sent to the County Clerks and County Surveyors of the State in accordance with the action of the Society as shown on page 14:

"DEAR SIR: At the last annual meeting of the Illinois Society of Engineers, attention was called to the frequent destruction or removal of stones or other marks set along the public highways for perpetuating land boundaries. A resolution was passed directing the secretary to mail a circular letter to the County Clerk and County Surveyor of each County in the State, and request that the various Commissioners of Highways be urged to exercise special care so that these valuable marks be not disturbed. These monuments are not intentionally destroyed, but in the grading of the highways they are often disturbed or removed innocently. The Commissioners and all persons who have charge of the grading on the country roads should be reminded that a stone, rod, or other monumental mark is liable to be found at any section corner, and also at any well defined fence line running from the road between section corners; that the destruction or removal of these is prohibited by State law (see Revised Statutes, Starr and Curtis, Chap. 121); and that great care should be exercised not to disturb any such monuments that may exist at these points.

"Attention was also drawn to the practice of some landowners of moving their fences out into the public highways. This practice should be vigorously resisted by those in charge of the public highways in the various townships, even if there is no other reason than that, in the absence or loss of a monument at a corner, a line mid-way between fence lines is liable to be assumed as the proper dividing line at some future date, and thus often error and litigation follow.

"These are matters of great moment to every citizen, and especially to the farmers; and we believe your attention need only be called to them to enlist your hearty co-operation, which we feel sure you will accord.

"Yours very respectfully,
"ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.'

WATER SUPPLY FOR SMALL CITIES. ✓

BY G. W. CHANDLER.

The question of an abundant potable water supply for small cities and villages is an important one. It is one with which the growing inland city located upon the prairie with no lake, pond, or river to furnish water even for fire protection must sooner or later grapple and solve. We have many of these small municipalities in our own State of Illinois. They came into existence years ago along some line of railway or at the junction of several roads, and by reason of their judicious location, natural resources, etc., have caused manufacturers to locate factories in their midst. These in turn have caused other industries to come in and build up a thriving city.

The problem which now presents itself is to provide an adequate supply of good potable water in abundant quantity that can be delivered at a reasonable price for domestic use to the factory, and for fire protection. In small communities the people must of necessity sink surface wells and depend upon these for their supply. This practice becomes more dangerous to the health of the community as the village grows, becomes more congested and populous, causing the surface supply of water to become more contaminated and unfit for use. The solution of the question seems to be the Artesian well, through which the city must draw its supply from the water bearing rock far below the surface. The whole question was encountered at Canton, Ill., and the author will describe the works there in order to indicate the proper solution of the problem.

The City of Canton is located near the central western part of the State, and like many others of its class first turned its attention for water supply to surface wells. Two of these wells were sunk 12 feet and 19 feet in diameter leaving a depth of 30 feet. Near these wells was built a small pumping station and a Worthington duplex direct pressure pump of 750 gallons per minute capacity, was installed. Under ordinary conditions this supply of water would last about two and one-half hours at a fire with two lines of hose in use. A few years later, in 1883, the city was visited by a severe fire which wiped out nearly one entire block of buildings near the center of the city and practically demonstrated the inefficiency of the water supply.

The City then put into use the Artesian well that had been drilled the year before in the Public Square. This well is 2,500 feet deep, the water standing in it 28 feet below the surface, and with a Hooker pump attached it yielded about 60 gallons per minute. A shaft was sunk 4 by 8 feet by 80 feet deep around this Artesian well for a storage supply, and a second pump was connected to this sump or shaft. These two pumps would pump out this supply in one and one-half hours, their combined capacity being 300 gallons per minute.

In 1893 the second serious fire occurred which destroyed the new opera house and damaged several adjoining buildings, and the water from the two pumping stations again proved insufficient.

In 1895 the second Artesian well was drilled in the southwest part of the city and was called the Avenue D well. This well is located on a plane 60 feet below the first Artesian well on the Public Square. It proved a flowing one, delivering 45 gallons per minute at the surface of the ground, the water standing in a pipe 15 feet above the surface. The well has a total depth of 1,646 feet and penetrates the St. Peter's sandstone 241 feet. The following is a correct log of the well:

0 to	14 ft.,	14 feet,	clay.
14 to	43 ft.,	29 feet,	blue shale.
43 to	88 ft.,	45 feet,	gray shale.
88 to	128 ft.,	40 feet,	blue shale.

128 to 129 ft., 1 foot, coal.
129 to 135 ft., 6 feet, fire clay.
135 to 170 ft., 35 feet, blue shale.
170 to 192 ft., 22 feet, gray shale.
192 to 194 ft., 2 feet, coal.
194 to 206 ft., 12 feet, slate.
206 to 261 ft., 55 feet, shale.
261 to 326 ft., 65 feet, limestone, sand, and shale.
326 to 341 ft., 15 feet, shale.
341 to 348 ft., 7 feet, black limestone.
348 to 540 ft., 192 feet, limestone, flint, sand, slate, and marl.
540 to 765 ft., 225 feet, shale.
765 to 828 ft., 63 feet, limestone.
828 to 1100 ft., 272 feet, limestone and shale mixed.
1100 to 1305 ft., 205 feet, Trenton limestone. (Water bearing.)
1305 to 1405 ft., 100 feet, limestone, sandstone and shale.
1405 to 1646 ft., 241 feet, in St. Peter's sandstone.

When the Trenton Rock was entered the well began to flow, it not being necessary thereafter to clean out the well with the sand pump. The surface water is cased off from the well by a 14-inch drive pipe extending down 40 feet from the surface. Inside of this pipe is the 10-inch well casing extending down from the surface 373 feet, the lower end having a steel shoe attached. Inside of this 10-inch pipe is the 6-inch pipe which extends on down 431 feet. These two pipes are made tight at their junction by means of a lead ring packer. The balance of the well below the 6-inch pipe, 842 feet, is a 6-inch hole through the rock, total depth of well being 1,646 feet.

A third pump house was built and a new Knowles direct pressure pump having a capacity of 1,100 gallons per minute was installed. This was connected to the Artesian well and pumped directly from it by suction at the rate of 90 gallons per minute. This supply, together with the other two pumping stations furnished the city with water until 1900 when the Air Lift Process was adopted for the Artesian well. A receiving well was built around the Artesian well holding 60,000 gallons of water, and the Air Lift Method increased the supply from the Artesian well from 90 gallons to 350 gallons per minute. The other two pumping plants were now abandoned. The Worthington pump from one plant was moved down and set up at the Avenue D Station, which with the Knowles pump makes a duplicate system of delivery to the city from the receiving well. The capacity of these two pumps together is 1,850 gallons per minute against a head of 75 pounds pressure in the city mains. The entire city water supply was now taken from this one Artesian well at the Avenue D Station.

In 1901 an additional storage of water was provided by building a reservoir just west of the receiving well. This was connected with the well by a 16-inch pipe. The reservoir holds in storage 1,137,000 gallons of water. The amount of water delivered to the city taken at an average per month for the past six months is 4,264,000 gallons, or 142,000 gallons per day. This requires six and three-quarter hours work from the air compressor, the discharge from the Artesian well being 350 gallons per minute.

The amount of water pumped from the Avenue D Station is measured by means of a 6-inch meter attached to the Knowles pump, and by a stroke counter attached to the Worthington pump. On the first day of each month a record is made up including all running expenses, such as fuel, oil, waste, salary, etc.; and the cost of pumping per thousand gallons determined. This cost taken on an average for the last six months was 6 1/3 cents per one thousand gallons. This price will be reduced as the amount of water pumped is increased, owing to the fact that the City employs a night engineer for fire protection who really has little water to pump for the night service.

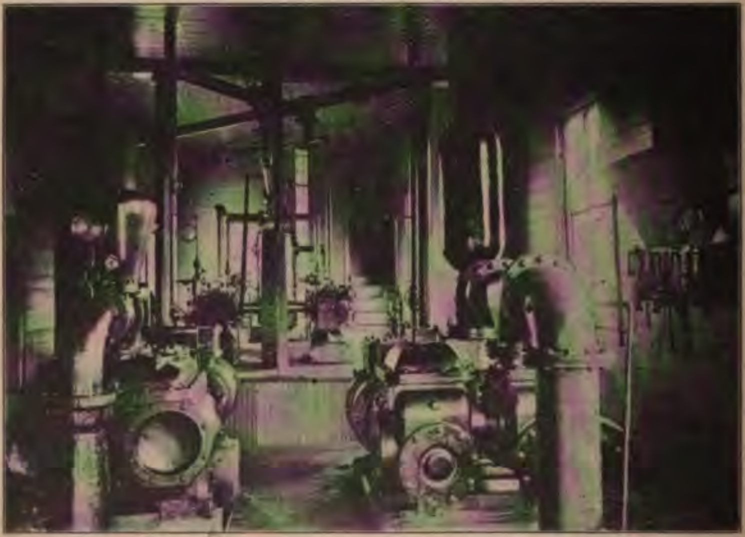
The City several years ago adopted the meter system making it compulsory for each water consumer to use a meter. These meters are furnished by the City at cost, and the water is sold at a rate per thousand gallons depending upon the amount of water used daily. This method seems to be a fair one both for the consumer and for the City, as each consumer pays for the water used and he can regulate the amount to suit his finances. This plan also checks the waste and leakage generally found where other methods are in use. The City now has in use some 420 meters, and the water rate is as follows:

1000 gals. or less per day, per 1000 gals.	30 cents.
1000 gals. to 5000 gals.	25 cents.
5000 gals. to 10000 gals.	20 cents.
10000 gals. to 20000 gals.	15 cents.
20000 gals. and over	12½ cents.

A discount of 25 per cent. is given if payments are made before the 10th day of each month.

The City now operates only the Avenue D Station and derives its entire supply from the one Artesian well by the Air Lift Process. The air compressor used is an Ingersoll-Sergeant, and it has capacity to furnish sufficient air for an additional well whenever needed in the future by the City. The air compressor is a duplex steam compound air machine. Steam cylinders are 12 inches in diameter, the low pressure air cylinder is 18¼ inches in diameter, the high pressure air cylinder is 11¼ inches in diameter, the length of stroke is 14 inches. At a speed of 155 revolutions per minute the machine will compress 637 cubic feet of free air per minute. At the present time the compressor is run at 74 revolutions per minute, using 300 feet of free air which is required for the use of the one Artesian well. In the first cylinder the air is compressed to 15 pounds, then it passes through the intercooler to the high pressure cylinder where it is again compressed before going to the air receiver and well. The air compressor has been in service over one year and has as yet required no repairs and is working finely. Where the greatest quantity of water is desired in a minimum space of time from one or more Artesian wells there is no doubt but that the Air Lift Process is the most economical, simple and practical method.

CANTON, ILL., PUMPING PLANT.



CANTON, ILL., PUMPING PLANT—ENGINE ROOM.

CANTON, ILL., PUMPING PLANT—ENGINE AND BOILER HOUSE.

CANTON, ILL., PUMPING PLANT—RESERVOIR.

Inside of the 10-inch well casing is hung the 6-inch pipe which extends down in the well 295 feet. Inside of this pipe is the 1¼-inch air pipe which extends down 255 feet, the upper end being connected to the air receiver. It takes an air pressure of 105 pounds to start the column of water in the well, after that 65 pounds is sufficient. The difference between these two pressures, 40 pounds, taken at 2 3-10 feet per pound gives 92 feet, which is the distance the water is lowered below the outlet when the well is working.

All the working machinery being above the ground, repairs and breaks are accessible and can be remedied without long delay.

The reservoir was built during the summer of 1901. It is rectangular in form, 100 feet long by 80 feet wide, the corners are turned with circles of 20 foot radius. It is 13 feet deep and holds 12 feet of water to the overflow line which is 12 inches below the top of the coping. The bottom is built of concrete 10 inches in thickness including a ¾-inch coat of Portland cement mortar. The two first footings of the side walls and the coping are also built of concrete. The concrete was mixed in the following proportions: One part of Portland cement to 3⅓ parts clean sharp sand to 7½ parts of medium crushed rock. This proportion for mixing was determined as follows: The per cent of voids in the crushed rock was found to be 40; the per cent of voids in the sand was found to be 30, giving 12 per cent for cement. Dividing by 12 we have 1 cubic foot of cement to 3⅓ cubic feet of sand to 8⅓ cubic feet of crushed rock; and reducing the crushed rock 10 per cent to insure a good mixture, we have 1 cubic foot of cement to 3⅓ cubic feet of sand to 7½ cubic feet of rock. As one sack of cement, 95 lbs., contains 9–10 of a cubic foot, we have by multiplication one sack of cement to 3 cubic feet of sand to 6¾ cubic feet of rock. The concrete was mixed in batches of 3 sacks of cement to 9 cubic feet of sand to 20¼ cubic feet of rock. The sand and crushed rock were measured out separately, the sand and cement being mixed together dry. The whole was shoveled into a pile, the rock being well wet, then shoveled over again and then shoveled into wheelbarrows and taken to the work. The cement coat was mixed 1 part cement to 2¼ parts sand. It was spread and worked smooth with the trowel.

The concrete work cost per cubic yard in place $5.38, as follows:

Medium crushed rock, 0.857 cubic yard, at $2.17 per cubic yard, delivered..	$1.86
American Portland cement, 0.856 bbl., at $2.50 per bbl., delivered.........	2.14
Sand, 10.1 bushels, at 100 lbs per bush., at 5¾ cents, delivered.........	0 58
For labor, mixing concrete, putting in place, etc., at 19 cents per hour.....	0.80
Total cost per cubic yard of concrete in place................. ...	$5.38

The crushed rock cost, delivered on the work, $2.17 per cubic yard of 2,500 pounds. The sand cost delivered, 5¾ cents per bushel of 100 pounds. The Portland cement cost $2.50 per barrel, or 62½ cents per sack. The mortar for the brick work was mixed one part cement to two and one-quarter parts sand. Each course of brick was laid and then grouted to secure a tight wall. The inside and outside of the wall were plastered with a ¼-inch Portland cement coat. Number one paving brick were used throughout the work, and the cost per cubic foot of brick masonry in place was 31 1-5 cents. The paving brick cost $6.50 per thousand delivered on the work.

The bottom of the reservoir has a slope of ten inches to the center from which leads out a 6-inch cast iron pipe to the small drainage well some 36 feet distant from the reservoir. A 6-inch gate valve is placed on the end of this pipe in the drainage well. The receiving well is also connected in a similar manner to the drainage well, and from the drainage well is laid a 10-inch drain having a fall of 12 inches to the creek some 200 feet distant. By the arrangement of these pipes and valves it becomes an easy matter to hold a supply of water in storage in one well while the other is cleaned and washed out. There is also an overflow pipe leading from the receiving well to the drainage well. The drain was laid first and used during the construction and excavation of the reservoir, and by means of a sump at its inlet the water was bailed out from time to time as the reservoir was built.

The first footing course of the reservoir wall was built of concrete. It is 40 inches in thickness, 12 inches in height, and sets on the finished bottom of the reservoir which projects 11 inches beyond it on the back. The second course, or footing, is 33 inches in thickness and 12 inches in height. On the top of this footing begins the brick wall which is 29½ inches in thickness finishing at the top to 13 inches in thickness under the coping. This coping is 17 inches wide, 6 inches thick, and is made of concrete marked off into blocks 6 feet in length. There are 20 pilasters in the brick wall 20 feet between centers, the pilasters being 51 inches in width and 29½ inches in thickness from bottom to top of wall, excepting 13 inches below the coping, where they are 21½ inches in thickness.

The reservoir holds 1,137,000 gallons of water. It is built 7 feet in the ground and 6 feet above and cost complete $7,906.36. The power to run the machinery at the pumping station is furnished by two 70 horse power tubular boilers. The cost of coal (mine run) delivered at the station is $1.61¼ per ton of 2,000 lbs., or 6 45-100 cents per bushel of 80 lbs. The average cost for coal taken for the last six months is $134.31 per month. The City employs two pumping engineers, one for day and the other for night service, their salary being $60 per month each.

Located on the City lot near the City building is the standpipe. This consists of a tank 40 feet high and 12 feet in diameter, set on a brick base 60 feet above the ground. It holds 28,000 gallons of water and gives 44 pounds pressure to the City. The City now has laid in its streets over 12 miles of water mains, ranging in size from 4 to 12 inches with 113 fire hydrants. An ample supply of water is now assured for six or eight years to come, when it may be necessary to put down a second Artesian well.

Perhaps the cost of the following items may be of interest:

Cost of the Artesian well complete, drilling, piping, etc.	**$ 4,371.27**
Laying water mains, and material to connect to City service	**1,814.71**
Knowles pump, setting up, etc , and boiler foundation	**522.98**
New 70 HP. boiler, 14 feet by 60 inches, with 54 3½-inch flues	**607.00**
New Knowles pump	**854.11**
Material, pipe fitting, valves, etc.	**417.56**
New buildings	**607.91**
	$ 9,195.53

In 1900 the following additions were made:

Receiving well, with building over same	**$ 1,628.99**
New air compressor, foundation, room, setting up, etc	**4,068.39**
Piping and fitting up Artesian well for the Air Lift	**336.39**
Connecting the two pumps to the receiving well, laying the 16-inch pipe to the reservoir, with gate valve	**334.38**
New boiler, with foundation, stack, connecting up, etc	**1,375.17**
New feed water heater, and connecting exhaust pipes, etc	**232.05**
Moving down and setting up the Worthington pump	**153.11**
New coal room, built addition to building	**102.40**
New stack for boiler, and painting same	**150.99**
Laying drain from drainage well to the creek	**107.14**
	$ 8,489.55
In 1901 the reservoir was built, costing complete	**7,906.36**
Making the total cost for the Avenue D plant	**$25,591.44**

REPORT OF COMMITTEE ON WATER WORKS.

Very few cities or villages in the State of Illinois having a population of more than 2,000 are not provided at present with a water works system; and, in fact, many villages with a much smaller population have constructed water works. However, the activity in water works construction throughout the State still continues. The growth in population in most of the municipalities of the State has created demands for additional water supplies, pumping capacity, extension of the mains, and various other improvements. The growth in population and the extension of sewers have also caused increased pollution in the surface water supplies; and in many cases surface supplies which have been heretofore satisfactory have become so contaminated as to make them dangerous to the health of the communities depending on such sources for their supplies.

Few of the larger cities of the State have water supplies of suitable quality and of ample quantity. Springfield, Bloomington, Joliet, La Salle and Moline and various other cities of smaller size are contemplating improvements in the source of supply. In most cases this is a question of both additional quantity and better quality, while in others the question of purification is paramount.

Until within a comparatively recent period the question of water purification was not considered a very important one in most of the cities of the State, but the bad condition of many of the water supplies has now made it an important matter worthy of the most careful attention of engineers.

In improving old water supplies and in seeking new ones it is important that the engineer should keep fully in mind the growth in population of the communities to be supplied and the future difficulties to be encountered in maintaining the quantity and purity of supply. The extravagant use of water in many of our municipalities has become a most important consideration. Two hundred gallons per capita and more has become a not uncommon rate of consumption. Such a consumption can not but be regarded as most extravagant and wasteful. The majority of English and Continental cities are maintaining a consumption of less than fifty gallons per capita, and many of the cities of our own country are not exceeding this amount. It is obvious that the use of such abnormally high quantities of water should be very carefully scrutinized and every effort made to decrease the consumption to a reasonable rate. In the management of water works, therefore, the use of reliable meters and of careful inspection is most essential. One hundred gallons per capita, even under present methods of management, should be a maximum limit and careful inspection and the aid of meters should materially reduce this.

In the selection of water supplies it should be understood that a water supply which is unpolluted and which from its nature cannot become polluted is always the most desirable, other things being equal.

The purification of a polluted water supply is a most difficult matter, and requires for its fulfillment careful and continuous expert supervision. If a pure supply which is beyond the reach of contamination can, by any reasonable means, be developed and maintained it should ever be the choice for a community.

In purification works careful design and careful construction, while essential elements, are really of secondary importance in comparison with careful supervision. No care in design of purification works will assure their proper operation; and a lapse of vigilance in the operation of such works, may result in an impure water-supply which may bring sickness and death to a community. The personal equation of operation should always be a prime factor in the design of an engineering structure, especially in such as may influence the health of the community.

In financial matters the municipalities of the State are unfortunately handicapped by the constitutional bonding limit of 5 per cent of the assessed valuation of the property within a municipality. The additional levy for running expenses of 2 per cent is found in most communities not more than sufficient to cover the annual expenses of the city. With very few exceptions our cities are already bonded to the limit for the construction of water works, electric light plants, and sewerage works; and they are, therefore, unable to meet the requirements for improvements which the growth of the cities seem to make almost indispensable. The difficulty arises from the fact that the assessed valuation is not the actual valuation, the 5 per cent bonding capacity being based on about one-fifth of the actual valuation of property within the municipalities, and is, therefore, really 1 per cent instead of 5 per cent.

In 1899, the Legislature passed a law permitting cities to issue water certificates payable out of the income of the water works. With these certificates the cities were to pay for the cost of improvements to the water works system. The Supreme Court, however, has recently decided, in the case of the City of Joliet, that such water certificates are a city debt and must be considered as coming under the 5 per cent limitation, at least under conditions similar to those at Joliet where the city already owns the water works plant, and is enjoying at present an income from the water works system. It is quite possible that in cases where a municipality is not already the owner of the system of water works and such certificates are issued against the income of a new works, or a water works to be purchased, the Supreme Court would decide otherwise. In such cases the municipality would create a debt, but at the same time provide a method of paying apart from the source of income already possessed by the city. In other States the Supreme Courts have decided that under such conditions a debt is not to be considered as a debt against the municipality; and it would not, therefore, be controlled by the bond limit. It was believed by those originating the law of 1899 that the law provided a way of avoiding the 5 per cent bond limitation, but the Supreme Court has decided otherwise.

It is most important that some method be devised for permitting cities to make such improvements in their water supply systems as will effectually protect the lives and health of the community. It is probably impossible to effect a constitutional change which would permit an increase in municipal indebtedness; for the need of such increase is only felt in the larger and more thickly settled communities. However, some means of accomplishing this seems to be at present one of the most essential requirements of our larger municipalities.

DANIEL W. MEAD,
Chairman.

REPORT OF THE COMMITTEE ON SEWERS.

Sewer work in Illinois is proceeding with more intelligence and good judgment the past few years than ever before. The proportion of cities which have no respect for the sanitary problems involved in a new sewer system is growing steadily smaller each year, and comparatively few independent sewers are being constructed without the careful consideration of a well defined general plan drawn by a competent sanitary engineer.

The importance of the proper disposal of the sewage when once collected is a problem which is receiving much more attention than formerly. Nearly all the modern methods of sewage purification require a few feet available fall at the outlet of the main sewer and the location of the outlet of the sewer system must be at some point where purification works may be advantageously located. These facts make it necessary for an engineer to be familiar not only with the Laws of Hydraulics and flow in sewers in order to intelligently design a sewer system, but he must also add to this knowledge a thorough understanding of the different methods of purification, in order that the main outlet may be properly located. Most small cities are requiring that purification plants shall be considered, even though they have no present intention of building them but deem it necessary that they should be designed in order that no mistakes may be made in the light of the present state of the art.

In the matter of independent sewer construction, mention may be made of the very large intercepting sewers now under way in Chicago to divert the sewage from the lake and empty it into the drainage channel. The largest of these is the 39th street conduit, which is 20 feet in diameter. It is being built beneath a busy street largely as a tunnel with compressed air and the use of a shield. It is about one-half completed. A very large intercepting sewer, 14 feet in diameter, is being constructed south along the Lake shore from the Lake end of the 39th street conduit, to take up the outflow from the main sewers of that part of the city. This work is being done by day labor under the supervision of the engineer in charge. Special machinery is employed and some very interesting problems are encountered. These sewers are entirely below the level of the Lake. A similar system is under construction on the North side of the city, the conduit being located on Lawrence avenue and leading from the Lake to the River.

During the past year, so far as known to your Committee, four Illinois cities have adopted and constructed septic tanks as part of their projected or completed disposal plant. These are Lake Forest, Lake County, population 2,500, capacity of tank 45,000 gallons.

Princeton, Bureau County, population 4,023, capacity 40,000 gallons.

La Grange, Cook County, population 3,969, capacity of tank about 100,000 gallons.

Glencoe, Cook County, population 1,020, capacity about 25,000 gallons.

Complete purification plants have been installed in Illinois during the past year at Glencoe, Cook County, and Lake Forest, Lake County. At the former place the septic tank followed by double contact beds has been installed, while at Lake Forest septic tank followed by automatic intermittent filtration has been put into operation. Both plants are interesting types and appear to be succestful.

Your Committee has not been able to gather statistics of new sewer systems constructed in the State with sufficient completeness to warrant publication. Several new systems have been designed and at least two systems constructed during the year in the State.

The Committee note the increasing use of double strength tile pipe for sizes over 12-inch. Some years ago this Society, through its Committee on Tests of Sewer Pipe, called attention to the inadequate strength of standard sewer pipe above the size of 12-inch. It was then estimated that with the pipe supporting all of the earth above it, the earth being water-soaked and computed as weighing 110 lbs. per cubic foot, pipe for depths up to 20 feet would require, with a factor of safety of two, the following strength:

3-inch......	1,500	15-inch......	9,000
4-inch......	2,000	18-inch......	10,000
6-inch......	3,000	20-inch.....	11,000
8-inch......	4,000	24-inch......	14,000
10-inch......	5,000	30-inch......	19,000
12-inch......	7,000		

This table must be reduced for the friction of earth along the sides of the trench and the resulting transference of pressure, a factor impossible to estimate; yet it will be seen that the larger sizes are proportionately far weaker than are the smaller sizes.

Prof. M. A. Howe, of the Rose Polytechnic Institute, made uniform tests some years ago, the results of which are as follows:

Average of	5	results for	4-inch pipe.....	17,300 lbs.
"	8	"	6-inch pipe.....	12,000 "
"	5	"	8-inch pipe.....	5,900 "
"	6	"	10-inch pipe.....	4,600 "
"	2	"	12-inch pipe.....	5,000 "

Other tests have been made lately and the net result has been to increase the confidence of engineers that double strength pipe for deep cuts and large sizes is a wise precaution.

J. W. Alvord,
G. W. Chandler,
H. E. Beasley.

DISCUSSION.

MR. J. W. ALVORD: The present sizes of pipes have stood under very adverse conditions but there have been some notable failures. The matter depends entirely upon the unknown transference of pressure. In some soils this transference is very large, in others very small. The speaker remembers the failure of half a mile of 18-inch pipe laid in a trench 12 feet deep. This was in clay soil and the trench was filled in freezing weather so that nearly all the weight of the material above came on the pipe.

THE PURIFICATION OF SEWAGE.

BY W. S. SHIELDS.

So much has been said recently on the subject of Sewage Purification that it is difficult to discuss it without repeating what is already well known among those who have given the subject a close study. The author will, therefore, be content to add to this general knowledge such data and ideas as he has gathered from an experience he has obtained through a close connection with the design and construction of several plants, with a hope of bringing out such discussion and comments as may result in benefit to our knowledge of this subject.

The first year of the new century has established the fact that the septic tank has passed the experimental stage and is now a fixed and important principle in the purification of sewage and while we have much to learn regarding its use and managements its function is recognized and its principles are fixed. The septic tank has come to stay.

In accepting the septic tank as a natural means for the purification of sewage we must not expect too much of it; it is not a complete process in itself, but a preparatory step and must be followed by other agents which will furnish sufficient oxygen to oxidize the remaining ammonias and organic matter in solution. Examples are becoming too numerous where engineers and city officials have built tanks of this character, copied in many instances from successful plants and placed then, without alteration, into systems which varied widely from the original system in conditions and character of sewage. They are, of course, very much disappointed to find that they do not work well and the odors are very bad. This, however, is but natural, and it will continue until the public can recognize that there is science even in this humble art, and that skill and experience are essential even to the proper disposal of their own filth refuse.

The septic tank has yet some elements of uncertainty and only time and usage will enable us to study it thoroughly. The skill of the chemist and bacteriologist, as well as the engineer, must be employed to discover its best arrangement, the time of passage or fermentation and the conditions which will produce greatest reduction of sludge and least odors.

It is doubtful if there is much merit in the submerged inlet and outlet; in fact, our best results have been with the inlets at the surface, or the center of the inlet pipe at the water line of the tank with baffle boards some three feet in front to spread and direct the flow downward. The outlet generally consists of a wide weir protected by another baffle board; and in some of the flexible tanks where the flow is made to pass through several long and narrow compartments, the baffle board is omitted entirely without any apparent bad results.

It is also doubtful if the air tight tank has any advantages, either in increased efficiency or in the prevention of odors. Comparison of effluents, so far as the sense can detect, does not favor the tight tank, but rather of a freely ventilated yet warmly constructed building over the tanks where the gases can readily be diffused into the air as they are thrown off. The practice of the writer's firm is to recommend masonry tanks with interior divisions for regulating different time of passage; this is covered with a low brick building with walls about six feet high with a wood gable roof finished with good quality of felt roofing; a door in each end, a few windows for light, and good-sized ventilators in each gable for ventilation. Without such ventilators the woodwork soon becomes saturated with dampness and decays very rapidly. This form of construction is not unsightly; it gives full access to the entire tank and where the final treatment requires a distributing tank it can readily be placed in the same building.

While the tank alone must be depended upon for the septic treatment, there is a wide range in the methods and materials which the engineer may select in his design for works to further complete the work of the tank. The object being to furnish sufficient oxygen to arrest the septic action, consume the ammonias, and oxidize the organic matters in the effluent. This may be done by dilution with sufficient running water; by carrying it a sufficient distance through wide shallow channels; by broad irrigation on land; by intermittent filtration through beds of sand, broken stone, cinder or other available materials; by contact beds, either single or double; or by some of the numerous forms of continuous or intermittent filters of peculiar and special construction.

So wide a range is there in this form of construction that there are but few localities or conditions found which do not afford some means for economical construction; and yet without an intimate knowledge of all details of the subject and the value of the various materials as filtering mediums, there is great danger of failure and a useless expenditure of money. The author thinks many engineers and officials are attaching too much weight to the English practice. The many conditions of climate and sewage strength may vary greatly in this country from English conditions, and from this cause there will be recorded within the next few years some failures; and yet even these must need be that we may the better learn. In the construction of works for the purification of septic tank effluent the efforts of the next few years will be to some degree experimental. The simplest and nearest to nature's fixed formula will win a place in common practice. Some methods will be found to be adapted to special conditions, while others will be rejected and the plants revised into other forms of treatment.

Experience has demonstrated that contact beds, when properly controlled and managed, will produce good results; but there is danger of their falling into discredit for lack of proper and skilled care. The necessity for regularity of filling and emptying by manual labor is a serious disadvantage and but few automatic devices can be found in the market which have proved successful in continued service. The great expense of building water-tight tanks for contact beds is another serious item, especially throughout our Western States where so many of our cities are well up to their bonded limit of indebtedness. In many instances their cost prohibits their use, even when conditions are favorable. The single contact beds, while they do not give results equal to the double, are open to the same objections unless the plants now nearing completion where the beds are built in natural earth excavation prove successful; even then it is a question whether better results cannot be secured by covering their surface with a layer of sand and using them as intermittent filters.

Of specially constructed aerating filters there is no end; and, with the exception of the cases where forced aeration is secured, the practice is somewhat experimental, and only long continued successful results will demonstrate their efficiency and durability.

The author has had some interesting experience during the last year with two plants in which local conditions made the septic tank followed by intermittent sand filtration the most economical method to adopt. Being granted considerable latitude (except as to cost) as to the carrying out of the plans, it was possible in both cases to produce a very satisfactory effluent, and at an extremely low cost for construction.

At Wauwatosa, Wis., a plant has been in operation since September 1st, purifying 100,000 gallons of sewage per day, with practically no cost of operation. It has received, however, a visit of sometimes once a week, and often twice a week from the Superintendent of Public Works, a gentleman of high mechanical ability. His inspection consists of recording the number of fillings recorded by the counter, temperature, etc., in extreme weather. He spends, perhaps, from a quarter to a half hour each visit at the plant. The six filter beds with a total area of one-fourth acre are dosed in rotation by means of a dosing tank and a ball-syphon device which discharges some 5,500 gallons of septic tank effluent at a dose on each bed in rotation. This device has operated without fault since its installation and through weather which was at one time

20 degrees below zero. The record shows that at one visit when the temperature was –4 degrees outside, the interior of septic tanks was –2 degrees; the water at both entrance and discharge of the tank was 48 degrees, the water in dosing chamber some 200 feet distant from the septic tank was 47 degrees, and the final effluent at outlet to river 44 degrees.

At no time during a week of extreme cold weather did the sand beds fail to work, although cakes of ice six or eight inches thick formed upon their surface. The interior of the septic tank was covered several inches deep with hoar frost, but no ice formed upon the surface of the tanks except in one unused compartment. The final effluent is clear and sparkling. The cost of the plants exclusive of the land was $5,370.

At Lake Forest, Illinois, the only available site for a plant was a narrow sand beach between a high clay bluff and Lake Michigan where the construction of piers to protect property from the eroding effect of the waves had formed a triangular beach of an acre or more in extent. The sand being already in position, the same scheme was adopted as at Wauwatosa. The plant consists of a septic tank and dosing chamber in one building. There are ten 10-inch Miller syphons controlled by a ball device and discharging upon ten sand beds of equal size. The total area is three-quarters of an acre. The surface of the beds is some seven feet above the lake level. They are protected from wind by a board fence, and from the seas by break water piers. Owing to the lateness of the season, the sand beds were frozen several feet in depth before sewage was turned upon them; and, while good results have been obtained so far, the frost still remains in part and causes some trouble and annoyance. This would not have occurred had the sewage been available before the deep freezing. This plant has a safe capacity of 250,000 gallons of sewage per day and was built at a total cost of $8,000 including lake shore piers and other protections. Much importance in both plants is attached to regular and intermittent feeding of the sewage to the beds.

The use of syphons for discharging the contents of the dosing chamber is very satisfactory where plenty of fall is available for storage or heading up, but it is impossible in many cases to get the required head without pumping. This fact has necessitated another form of device which can control the flow without loss of head. The 10-inch syphons can be operated with 18 inches depth of water and with bottom of bells 12 inches above the bottom inverts of outlet limb. The syphons at Wauwatosa operating under 24-inch head discharge 5,500 gallons in 7⅓ minutes; while at Lake Forest, working under 30-inch head, the tank was emptied of 8,000 gallons in ten minutes.

Both of these plants will receive the author's care and attention until they prove themselves able to continue their present efficiency or develop defects which will be studied and if possible remedied.

It is the hope of the people along the Lake shore north of Chicago that the plants at Glencoe and Lake Forest may demonstrate that all sewage can be purified before being allowed to enter the Lake from which their water supply is now obtained; and, unless unforeseen disaster overtakes these plants, they will demonstrate that it will be possible for the cities of Evanston, Wilmette, and Winnetka to join in one common plant, and treat the sewage of this district in a satisfactory manner at one-fifth the cost of the proposed open water way to connect with the Sanitary District of Chicago.

One very essential element which we Western engineers must contend with and which our Eastern brothers do not fully appreciate, is the limitation of funds available for such purposes as sewage purification in the great majority of our Western cities. People in Western towns, as a rule, have to be more economical than in the older and more wealthy Eastern cities, and it is difficult in this section of the country to raise sufficient money to carry out such improvements as are found necessary. We see our Eastern engineers spending anywhere from $40,000 upward for sewage purification work for places of not more than 5,000 population, while we for Western cities of even greater population must accomplish the same results within a small fraction of such amounts. Our work, therefore, appears so far insignificant and of small account; our consolation, however, must be in the fact that it is not the engineer who expends the largest sum for the public improvements who displays the most skill, but he who can accomplish the most effective results for the amount available is the one, perhaps, who renders truly efficient service.

DISCUSSION.

MR. J. W. ALVORD: There are a number of patents on the septic tank. An English firm claims to have patents on the whole principle. They have threatened the speaker's firm with suits for using such tanks. A Boston firm also claims to have patents, and they write letters to people who are contemplating to use this system. There are also patents on the devices for rotating the sewage on the filter beds. The speaker's firm has found it necessary to patent their designs to keep some of these people from taking the ideas and patenting them and selling them back. The speaker's firm is putting in septic tanks in defiance to the broad patents; and, although they have put in sixteen tanks, they have had no trouble.

The septic tanks have been in use in this country so short a time that not much can be said about results. One of the tanks put in by the speaker's firm has been in use about three years, others for about a year. In none of these cases has there been any complaint about odors from the effluent.

A working theory was developed from the oldest tank mentioned above. It was decided that every particular sewage has its fermentation period. There is a certain period which leaves the sewage in the best state for secondary purification. If sewage remains in the tank too long, poisons are developed which kill off the bacteria that operate in the tank, or at least impair their vitality for a time, so that the tank rapidly fills with organic matter. This is yet largely a theory; it was developed from the first tank built by the speaker's firm and he feels that it has not yet been fully substantiated. This fermentation period was found to be much shorter than used in England, which is probably due to the fact that English sewage is much stronger. In general it has been found by the speaker that periods of from five to six hours are successful with sewage such as he has encountered.

In case the sewage is very much different from that for which the tank is designed this period of rest is much different from that intended. To provide against this the speaker's firm has introduced what might be called elastic tanks. These tanks are made up of several compartments which can be combined so as to keep the time of flow through the tank constant.

The function of the septic tank is primarily to break down suspended matter in the sewage and render it easier to purify by filtration or secondary purification. The work of the septic tank is most complete when the sewage is freest from suspended matter. In that condition it is capable of quick and easy filtration. It is by no means pure; it is full of organic matter. If there is no stream into which it can be discharged and diluted, it must be purified or it will prove a great nuisance.

PROF. A. N. TALBOT: It is the opinion of engineers generally who have looked into this matter that no one need fear having to pay any royalty upon any patent which needs to be used in the construction and operation of the septic tank. The only patent, so far, which it would be necessary to use is some siphon or in connection with the secondary purification, some rotating device.

The interval in which it is necessary to clean the septic tank depends on the size of the tank, the amount of sewage passing through it, and whether there is some means of catching the silt and sand in the sewage before it enters the tank.

Of course there is a great deal yet unknown in sewage purification, but there seems to be some misconception among the public at large and some terms are at present used rather loosely. It is unfortunate to use the term "period of rest" in speaking of the relation between the rate of flow of sewage and the capacity of the tank. In the first place the sewage does not stay in the tank as long as the capacity rating would indicate, since there is considerable depth of dead water, and in the next place within wide limits the time of passing through the tank makes little difference. There is very little change in the sewage in solution in passing through the tank. The time of passing through the tank may vary considerably without affecting the proportion of matter in suspension retained through a sedimentation or subsidence action. The matter which is held back remains in the tank until it can be acted upon by the bacteria and the question is whether there is sufficient surface in the tank to allow this matter to be reduced by bacterial action and not be covered by other matter coming in before the reduction is complete. If the septic tank is acting very slowly there will have to be a very large surface capacity in order that this organic matter may be properly changed by bacterial action. As tanks have about the same depth, the surface referred to is nearly proportional to the cubic capacity of the tank; and hence the cubic capacity must be large enough to allow this fermentation action to go on. While, then, a septic tank must be properly proportioned, the use of this term "period of rest" is somewhat misleading.

MR. W. C. LEMEN: The plant at Paris, Ill., has no filter bed and the speaker understands that a land owner adjacent to the stream into which the effluent is discharged threatened with a lawsuit if he were damaged.

MR. W. G. POTTER: In one place the speaker knows of there is likely to be a damage suit because of the effluent from a septic tank. The tank was built from plans of another tank designed for another purpose altogether. It was entirely too small and a damage suit will be instituted if filter beds are not added.

As to suits for infringements on patents of the septic tank, the speaker knows of none. Suits have been threatened but none have ever materialized.

Watson C. Holbrook.

During the year the Society lost by the death of Watson C. Holbrook one of its most respected and valuable members.

He was born February 17, 1848.
He died April 11, 1901.

After graduating from the Rock Island High School he entered the University of Wisconsin, graduating in the scientific and civil engineering course. He was surveyor of Whiteside County for twenty-two years and was well known throughout Northern Illinois. He took great interest in scientific matters, being considered an authority on Indian mounds. He also wrote on pioneer and prehistoric times of Illinois. He designed the steel bridge over the Mississippi River at Fulton and also several Rock River bridges.

He was an active and enthusiastic member of the Society, and his last paper, "An Examination of Recent Decisions of Interest to Civil Engineers and Surveyors," has proved of considerable value.

The Society feels the greatest sympathy for his widow and children.

ANNUAL REPORT OF THE EXECUTIVE SECRETARY-TREASURER.

FOR THE YEAR ENDING JANUARY 24, 1902.

To the Members of the Illinois Society of Engineers and Surveyors:

GENTLEMEN: Below is given my report as Executive Secretary-Treasurer for the year ending January 24, 1902:

RECEIPTS.

Balance on hand January 25, 1901	$ 34.00	
Received for Initiation Fees	33.00	
Received for Annual Dues	349.00	
Received from Sale of Reports	5.10	
Received from Advertising	351.43	
Total		$772.53

DISBURSEMENTS.

Printing Sixteenth Annual Report	$269.03	
Stenographer at Sixteenth Annual Meeting	50.00	
Postage and Express	133.97	
Miscellaneous Printing, Cuts for Report, and Other Expenses	106.21	
Salary Executive Secretary-Treasurer	150.00	
Balance on hand January 24, 1902	63.32	
Total		$772.53

The finances of the Society are in good condition.

There are now 114 members in good standing.

Sixteen hundred copies of the Sixteenth Annual Report were printed.

Exchanges were made with the following list of Societies:

Ohio Society of Engineers.
Assoc. Engineering Societies, University of Illinois.
Civil Engineering Society of Purdue University.
Connecticut Civil Engineers and Surveyors.
Michigan Society of Engineers.
Indiana Society of Engineers.
Engineering Association of the South.

Copies of the reports of these Societies have been sent to all members in good standing.

There seems to have been some difficulty among the Societies of the country during the year in the matter of getting out reports. Most of them could not be obtained until quite late and some not at all.

Copies of the Sixteenth Annual Report have been sent to the following libraries:

Library of State University of Iowa.
Library of State University of Tennessee.
Library of State University of Missouri.
Library of State University of Illinois.
Chicago Public Library.
Library of Oberlin College.
Library of Rose Polytechnic Institute.
Library of Massachusetts Institute of Technology.
Library of Washington University.
Library of Rensselaer Polytechnic Institute.
Library of University of Chicago.
Library of Armour Institute of Technology.
Illinois State Library.
Engineering Library of University of Illinois.
American Society of Civil Engineers.
Congressional Library.
Library of the Engineering Department of University of Michigan.

Library of the Engineering Department of Cornell University.
Library of the State University of Ohio.
Chicago North Side Public Library.
Library of the University of Minnesota.
Library of Kansas University.
Library of State Historical Society of Wisconsin.
Western Society of Engineers.
Library of Purdue University.
Montana Society of Engineers.
John Crerar Library.
Civil Engineers' Club of Cleveland, Ohio.
Mr. Gardner T. Swartz, Secretary State Board of Health, Providence.
Engineers' Club of Philadelphia.
U. S. Geological Survey.
Public Library, Cincinnati.
University of Washington.

Respectfully submitted,

A. L. KUEHN,
Secretary-Treasurer.

JANUARY 24, 1902.

EIGHTEENTH ANNUAL REPORT

OF THE

ILLINOIS SOCIETY

OF

ENGINEERS AND SURVEYORS

PROCEEDINGS OF THE SOCIETY

AT THE

EIGHTEENTH ANNUAL MEETING

HELD AT

AURORA, ILLINOIS, JANUARY 21, 22 AND 23, 1903.

PUBLISHED ANNUALLY BY THE SOCIETY.

PRICE FIFTY CENTS.

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1903

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J. C. QUADE, *Chairman;* T. W. SNOW, R. H. SLOCUM.

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CHANGES OF ADDRESS: Please advise the Secretary promptly of any changes of address.

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HODGMAN, F.............Climax, Mich.

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ABELL, W. W., Civil Engineer.............Elgin
ALVORD, JOHN W., Consulting Engineer......127 Hartford Building, Chicago
ANDERSON, C. G., Civil Engineer.............24 Arcade Building, Peoria
ASHLEY, BURTON J.............523 The Temple, Chicago
ATWOOD, L. P., Superintendent, Rio Grande, Sierra Madre & Pacific Ry., ...P. O. Box 687, El Paso, Texas
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Malcolm, Charles Wesley, Instructor in Civil Engineering, University of Illinois..............................511 E. Green St., Champaign

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Maury, Dabney H., Jr., Consulting Engineer, 129 N. Jefferson Ave., Peoria

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Paddock, Henry G., City Engineer..................................Moline
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Prout, Charles A., City Engineer...............................Wheaton
Purington, D. V...............................4800 Kenwood Ave., Chicago
Quade, John C., Civil Engineer for Western Tube Co.................. ....102 N. Burr St., Kewanee
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Rossiter, F. C......................Room 1, 91 Washington Street, Chicago
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Shepardson, John Eaton, Civil Engineer.................Shabbona Grove
Sherman, Leroy K., Civil Engineer, Geisel Construction Co............ ....715 Locust St., St. Louis, Mo.
Shields, W. S., Civil Engineer.............1715 Marquette Building, Chicago
Sims, Lewis J., Drainage Engineer................................Lincoln
Slocum, Roy H., Instructor in Theoretical and Applied Mechanics, University of Illinois........................926 W. Illinois St., Urbana
Smith, Owen T., Engineer and Superintendent for Water Company, Freeport
Snow, T. W., Manager, The Otto Gas Engine Works.................. ....360 Dearborn St., Chicago
Stevens, Hubert A., City Engineer.................104 Burttison St., Joliet
Stewart, John T., Civil Engineer (U. S. Geological Survey)........Paxton
Stowell, Chas. C., Civil Engineer.............328 N. Fourth St., Rockford
Talbot, A. N., Professor of Municipal and Sanitary Engineering, University of Illinois..Urbana
Tallyn, L. L., (Instructor in Civil Engineering, University of Illinois) ....Present address unknown
Tarrant, Wm. H...Champaign
Thompson, A. D..Peoria
Tratman, E. E. R., Associate Editor *Engineering News*............... ....1636 Monadnock Block, Chicago
Treichler, Wallace, Civil Engineer..........................Rock Island
Vial, Robert C., Asst. Engineer, C. & W. I. R. R.................LaGrange
Whittaker, E. H., Drainage Engineer..............................LaSalle
Whitley, Noah, Surveyor...............................Court House, Joliet
Windes, Frank A., Civil Engineer for the Villages of Winnetka, Glencoe and Fort Sheridan..........................P. O. Box 195, Winnetka
Withington, J., Surveyor.........................115 So. 17th St., Mattoon
Wrightman, Geo. F., Civil Engineer................................Lacon
Zeter, John, County Surveyor....................................Lincoln

PAST PRESIDENTS.

Ira O. Baker, - -	1886 and 1887	Daniel W. Mead, -	1894 and 1895
C. G. Elliott, - -	1888 and 1889	Charles C. Stowell,	1896 and 1897
Arthur N. Talbot,	1890 and 1891	Almon D. Thompson,	1898 and 1899
Samuel S. Greeley,	1892 and 1893	Charles C. Brown, - -	1900
Henry G. Paddock, - - -	1901 and 1902		

NOTICES.

ANNUAL MEETING: 1904.

The Nineteenth Annual Meeting will be held at the University of Illinois, Champaign, on January 20, 21 and 22, 1904.

As this will afford an exceptional opportunity for seeing the work of the University, and especially that of the College of Engineering, it is hoped that all members will arrange to attend. The meeting will be a pleasant gathering of retiring, practising and coming engineers, and the educators of engineers.

Due notice will be given as to the program, accommodations, etc.

COMMITTEES.

It is hoped that every committee will prepare a report and also secure some papers relating to its particular subject. All committee members have been notified of their appointment, and the members of each committee are asked to meet or correspond with each other in regard to their plans of work, and also to assist in the preparation of the reports.

Cards have been sent out giving the names of the members of the several committees. See if your name is on the list (on the card or in this report). If so, please make a start to help the work along, if you have not already done so. Do not wait for others to start, but take a lead.

Individual papers will be welcome, and members are invited to prepare papers and so share in the work.

It is very desirable that there should be a strong list of papers and reports for the meeting at the University. Papers and reports should be in the hands of the Secretary by December 31, to give time for arranging the program.

MEMBERSHIP.

Members are urged to interest their friends in the Society, and invite them to become members. Applications for membership may be made to the Secretary at any time.

Members receive the Proceedings of this Society and also of some eight or ten other societies of engineers and surveyors.

Entrance fee (to be sent with application)	$3.00
Annual dues, first year	2.00
Annual dues, each year after	4.00

ADVERTISEMENTS.

A large and varied list of advertisements accompanies this report and members are asked to look these over, as being interesting and instructive as well as commercially useful.

In writing the advertisers for information, etc., please mention that you have seen their advertisements in the Report of the Illinois Society of Engineers and Surveyors.

PROCEEDINGS

OF THE

EIGHTEENTH ANNUAL MEETING

OF THE

Illinois Society of Engineers and Surveyors

HELD AT

AURORA, ILL., JANUARY 21, 22 AND 23, 1903.

JANUARY 21, 1903. AFTERNOON SESSION.

The Eighteenth Annual Meeting was called to order at 2 o'clock in the Council Chamber of the City Hall by the President, Mr. Henry G. Paddock.

President: Gentlemen, the hour has arrived to call this meeting to order. The first thing upon our program is the address of welcome by His Honor, Mayor Alschuler, of Aurora, whom I have the pleasure of introducing to you.

Mr. Alschuler: Mr. Chairman and Gentlemen: It affords me great pleasure to welcome you to our city. I see you are not here in great numbers yet, but I suppose what you lack in numbers you make up in quality. We have been welcoming different societies from all over the State for the past year, and Aurora is getting to be quite a convention city. You will find it a progressive, energetic city. I notice by your program that there will be very many papers read and subjects discussed, and I judge that the meeting should be not only of profit to yourselves but also to the general public. Our own engineers will do what they can for your entertainment, and our people are glad to welcome you. Gentlemen, I thank you, and I trust your meeting will be a successful one.

President: The response to the Mayor's address will be given by our Vice-President, Mr. Tratman.

Mr. Tratman: We are very pleased to be welcomed to your city, Mr. Mayor. We know it as a railway city, as a manufacturing city, a city of many important industries, and possessing many feature of engineering interests. Among these features of particular interest is the third-rail electric railway to Chicago, the only railway of its kind in this part of the country and one of the very few in the entire country, although it is an example of what we may expect in the future. Another point of interest is the new Public Library building, the special engineering feature of this being in the foundation, which consists of concrete piles. These are now hidden out of sight, and may not seem of much importance to the general public. To engineers, however, this construction is of great interest, both for its novelty and its practical importance. The city's water works, its manufacturing plants, and the railway shops are other points of technical interest.

You may perhaps ask, Mr. Mayor, who and what are the members of the Illinois Society of Engineers and Surveyors. They are civil engineers, some in public office as city engineers, etc., and others in private practice. They are the men who plan and design water supply systems, city sewerage and sewage disposal works, drainage works, and the development of water power. They build the railways and canals, they build the street railways, they lay out and pave the streets, they survey the lands and properties, and they design bridges, foundations and buildings. In fact, they design and supervise almost every kind of construction work for the comfort and convenience of mankind. Many of our members are graduates of, and some of them are professors at, the State University of Illinois.

I will not take up more time with this impromptu speech, after these few words as to your city and our Society. In the name of the Illinois Society of Engineers and Surveyors I beg to thank you, Mr. Mayor, for the welcome you have given us to this city.

President: One of the duties of the President is to prepare what is called an annual address, and in pursuance of this duty I will now proceed to deliver the address.

After the President's address, the report of the Committee on Surveying was presented by Mr. W. M. Hay, and this was followed by a general discussion.

A paper on "The Real Estate Records of a Great Railway System" was then read by Mr. H. I. Orwig.

This was followed by a discussion on plats of surveys to accompany building plans in towns and cities.

A paper on "The Duties of the Consulting Engineer of the Illinois Railroad Commission," by Mr. Frank P. Ewald, was next read by Mr. E. E. R. Tratman, in the absence of the author. It led to an interesting discussion, particularly on the question of eliminating the grade crossings of electric and steam railways. On motion of Mr. J. M. McNabb, the Chair appointed Mr. J. G. Melluish as a committee of one to prepare a resolution covering the question of additional legislation on this subject, to be presented later on in the proceedings.

A paper on "Farm Drainage" was then read by Mr. L. Z. Jones, and this also was followed by a discussion.

The meeting then adjourned. No meeting was held in the evening.

JANUARY 22, 1903. MORNING SESSION.

The meeting was called to order by the President at 8:30 o'clock.

The report of the Committee on Railways was read by Mr. E. E. R. Tratman, Chairman of the Committee.

It was moved by Mr. W. M. Hay that a nominating committee be appointed to select officers for the coming year. This was carried, and the President appointed W. M. Hay, J. L. Clark and J. M. McNabb as the Nominating Committee.

A paper on "The Proposed Co-Operative Survey of Illinois," by Mr. W. H. Herron, was then read by the author.

A paper on "Work Train Methods and Records on the Rio Grande, Sierra Madre & Pacific Railway," by Mr. L. P. Atwood, was then read by Mr. E. E. R. Tratman in the absence of the author.

A description of the "Testing Laboratory of the Chicago, Burlington & Quincy Railway at Aurora" was given by Mr. Max H. Wickhorst.

A paper on "The Third-Rail Electric Line of the Aurora, Elgin & Chicago Railway," by Mr. E. E. R. Tratman, was then read by the author.

It was moved by Prof. A. N. Talbot that the election of officers and selection of the place for the next meeting be made a special order of business for 9 o'clock at the evening session. This was carried.

The report of the Committee on Water Works was presented by Mr. J. W. Alvord, Chairman of the Committee, and was followed by a discussion.

A discussion on "The Present Improvement Laws of the State of Illinois" was then taken up.

The meeting then adjourned.

JANUARY 22, 1903. AFTERNOON EXCURSION.

A special train provided by the Chicago, Burlington & Quincy Railway, took the party to the water works plant, under the guidance of Mr. H. D. Hallett, Consulting Engineer for the works, and Mr. M. G. Stolp, City Engineer. The party then visited the plant and new machine shop of the American Well Works, being conducted by Mr. M. T. Chapman, President of the firm. Here deep-well pumps, air compressors, and valves and other apparatus for deep-well pumping were seen in course of manufacture.

The party then proceeded to the shops of the Chicago, Burlington & Quincy Railway, where Mr. Max H. Wickhorst, Engineer of Tests, took them in charge and conducted them through the engine, machine, boiler and car shops, and finally the laboratory. He also showed them the dynamometer car and explained the apparatus with which it is equipped, as described in a paper read by him at the meeting.

JANUARY 22, 1903. EVENING SESSION.

The meeting was called to order by the President, at 8 o'clock.

The following resolution was submitted by Mr. J. G. Melluish, relating to the discussion on grade crossings at the afternoon session of the previous day:

RESOLUTION: GRADE CROSSINGS.

It is Resolved by the Illinois Society of Engineers and Surveyors at its eighteenth annual meeting, in Aurora, Ill., January 23, 1903:

That it recommends to the Legislature of this State an amendment of Section 114, Paragraph 156 (Starr and Curtis revised statutes), which shall give the Railroad and Warehouse Commission power to enforce the elimination of crossings at grade, both of existing and prospective crossings of steam railways with steam railways, steam railways with electric railways, and electric railways with electric railways; and that the cost of the elimination of existing grade crossings which the Commission may from time to time decide to abolish, should be equitably apportioned between the railways, the State, and the town or city.

J. G. MELLUISH,
Chairman of Committee.

This was duly seconded, voted upon, and carried. Copies have been sent by the Secretary to the Railroad Commission of Illinois, and to some of the technical and daily papers.

Mr. W. M. Hay moved that in the continued absence of the Secretary an acting secretary be appointed. This was carried, and the President appointed Mr. W. H. Herron.

Mr. W. M. Hay presented the following resolution, drawn up by the Committee on Surveying as the outcome of the discussion on the Committee's report on the previous day, it being the judgment of the the Committee that the law relating to Plats is not sufficiently strong.

RESOLUTION: PLATS.

Resolved, That it is the opinion of the Illinois Society of Engineers and Surveyors that the present law in relation to "Plats" should require the surveyor's certificate to contain a correct description of the land sub-divided; and that permanent monuments of stone, iron or equally durable material be required to be set by the surveyor in number equal at least to the number of angles in the exterior boundaries of the land sub-divided.

This was duly seconded, and carried.

A discussion on "The Stability of Earthwork Placed on Old Railway Embankments" was then taken up by Mr. L. Z. Jones and Mr. J. C. Quade.

A paper on "The Relative Strength and Cost of Natural and Portland Cement Concrete for Street Pavements," by Prof. A. N. Talbot, was then read by the author.

President: The time has arrived for the election of officers and deciding upon the place for the next convention. Section 2 of the By-Laws says, "Ten members shall constitute a quorum for the transaction of business." We have a quorum present and can transact any business that may come before us. Is the Committee on Nominations ready to report?

Mr. W. M. Hay: The Committee has agreed to place the following in nomination for office:

President, John W. Alvord.
Vice-President, John C. Quade.
Trustees, D. W. Mead and J. G. Melluish.

It was moved by Prof. A. N. Talbot that the acting secretary be directed to cast the ballot of the Society for these nominees; the President and Vice-President for one year, and the Trustees for two years.

The motion was seconded, and carried. The acting secretary then cast the ballot, and the officers were declared duly elected.

For the place of next meeting the following were nominated:

Bloomington, East St. Louis, Monmouth and Champaign (University of Illinois). A ballot was taken, and Champaign (University of Illinois) was selected.

A discussion on "The Applicability of the Septic Tank to Sewage from a Combined System of Sewerage" was then opened by Prof. A. N. Talbot.

The meeting then adjourned.

JANUARY 23, 1903. MORNING SESSION.

The President called the meeting to order at 8:30 o'clock.

A paper on "The Growth of Schools of Engineering," by Prof. A. N. Talbot, was read by the author.

A discussion on "The Advantages of the Use of Concrete in Construction" was next taken up.

A paper on "Open Ditch Drains," by Mr. P. C. Knight, was read by Mr. J. C. Quade, in the absence of the author.

The Executive Committee presented the following report:

> The Executive Committee desires to report that in the absence of the Executive Secretary and Treasurer it is impossible to make out the usual report, as provided by the constitution, and the Committee is therefore compelled to turn the matter over to the incoming administration.

The new Executive Committee announced that it had elected Mr. E. E. R. Tratman as Executive Secretary and Treasurer for the ensuing year.

It was moved by Mr. H. D. Hallett that a committee be appointed to draw up resolutions of thanks for courtesies extended to the Society. This was seconded and carried, and the President appointed Prof. A. N. Talbot, Mr. J. C. Quade and Mr. B. J. Ashley.

The following resolutions were submitted, seconded, and carried unanimously by a standing vote:

RESOLUTIONS OF THANKS.

Resolved, That the Illinois Society of Engineers and Surveyors desires to record its appreciation of the many courtesies and facilities which it has enjoyed at this meeting at Aurora.

To the Mayor and City Council for the use of the Council Chamber. To the Mayor for his cordial greeting. To the Superintendent and the Engineer of the water works for the opportunity of inspecting the water works plant. To the Superintendent of the Chicago, Burlington & Quincy Railway for transportation to the water works, and the pleasant visit to their shops. To Mr. Max H. Wickhorst for courtesies received at the C., B. & Q. Ry. shops. To Mr. M. T. Chapman for the opportunity of visiting the factory of the American Well Works. And especially to the Chairman of the Local Committee, Mr. H. D. Hallett, and to Mr. M. G. Stolp, City Engineer, for the local arrangements made and for the hospitable and pleasant treatment received during our stay.

Resolved, That the Executive Secretary be directed to convey an expression of the thanks of the Society to those herein enumerated.

A. N. TALBOT, Urbana.
JOHN C. QUADE, Kewanee.
BURTON J. ASHLEY, Chicago.

A discussion on "The Exclusion of Waste Products from Sewers" was then taken up.

The incoming President, Mr. John W. Alvord, was then introduced and took the chair.

It was moved by Mr. B. J. Ashley that a cordial vote of thanks be tendered to the retiring President, Mr. Henry G. Paddock, for the efforts made by him to build up the Society during his two terms of office. This was seconded, and carried unanimously.

The meeting then adjourned until the annual convention of 1904.

ENGINEERING FEATURES OF AURORA, ILL.

The Convention City, 1903.

It will be of interest to briefly mention the engineering features of the city of Aurora.

Streets and Sewers.—Mr. M. G. Stolp, City Civil Engineer of Aurora, furnishes the following information:

"In 1902 we laid 5.7 miles of asphalt paving. This, together with that already laid, makes the total length of asphalt paving 9.5 miles. Our brick paving is of Hallwood block, and Galesburg and Streator brick; it amounts to 2.5 miles."

"Our sewer systems are on the combined plan, and the four districts approximate 70 miles of main sewers; 60 miles of these sewers have been in use for ten years. We have one system under construction, and another under way, amounting to about three miles in all."

"The sum of $513,811 has been expended in the city for paving alone in the past ten years. The cost of the sewer systems already built was $450,000."

Water Works.—The water supply is obtained from four deep wells by the Chapman air-lift system, and delivered to a new concrete reservoir of 2,000,000 gallons capacity. From the reservoir the water is pumped to a standpipe, or directly into the distribution mains. The Board of Public Works decided, in 1902, to increase the supply from the wells by installing the air-lift system, and also to construct this new storage reservoir. The reservoir is 140x150 feet on top, 12 feet deep, and has corners of 20 feet radius. A peculiar feature is that the sides are made concave, with a radius of 24 feet. This plan was adopted by Mr. Hallett in order to allow for the expansion of ice in case of the water freezing. In the pumping station are two Deane pumps, a Nordberg triple-expansion pumping engine and an American air-compressor for the Water Works, built in 1885 by the city.

Supply—Three artesian wells, 1,380, 2,440 and 2,270 feet deep. Pumping to stand-pipe.

Pumps—Capacity, 6,000,000 gallons; two 3,000,000-gallon Deane engines. Pump to be added, Nordberg 6,000,000-gallon quadruplex. Bituminous coal used, average cost, $1.50 per short ton.

Distribution—Mains, 49 miles; cost of extensions met by direct taxation. Taps, 2,900; made by city for $2.50. Services, lead; paid for by consumer. Meters, 1,041; owned and repaired by consumer; controlled by city. Use of meters compulsory for all houses with water-closets, all stores and factories. City can compel use of meters and consumer may have one. Hydrants, public, 430.

Consumption—Average 1,300,000 gallons.

Pressure—Ordinary, 70 lbs.; fire, 120 lbs.

Financial—Cost, $460,000. Bonded debt, $168,000, at 5 per cent.; due, $46,000 in 1900. 1905, 1910 and balance later on. Expenses: Operating, $9,884; interest, $8,400. Revenue: Consumer, unmetered, $1,759; metered, $1,041.

Management—Board of Public Works.

(From "The Manual of American Water Works," 1897.)

Concrete Piling.—The speech of the Vice-President referred to the foundations of the Public Library, these foundations consisting of concrete piles reaching through 14 feet of filled material to solid rock. The method of construction consists in first driving a steel pile fitted with a sheet iron casing. This pile is driven by a pile driver in the usual way. The pile is in two parts, divided lengthwise, and when driven it is collapsed and withdrawn, leaving the casing in place. The hole is then filled with concrete. There are 142 piles, 20 inches diameter at the top and 13 inches at the bottom, this slight taper being on account of the piles resting on rock. In soft material a much greater taper is used. The concrete is composed of 1 part Portland cement, 2 parts sand and 4 parts stone. The heads of the piles were afterwards embedded in the concrete foundation walls.

Railway Shops.—The Chicago, Burlington & Quincy Railway has large locomotive and car repair shops, but the shops and equipment are old. Some particulars of the laboratory work are given in one of the papers read at the meeting.

General Summary.—The following general summary of the public works of the city is taken from "The Municipal Year Book," 1902:

Population—24,147.

Assessed valuation (1899), $4,119,980.

Mayor, George Alschuler; City Engineer, M. G. Stolp; Superintendent of Streets, Henry Rand; Chairman of Health Board, G. W. McDonald; Chief of Fire Department, Adam Schuberline.

City Owns: Water works; Superintendent, W. K. Reese. Sewers; Superintendent, J. W. Linden. Electric lights; Superintendent, C. C. Hinckley.

Companies Own: Gas works; Aurora Gas Light Co. Electric lights; Aurora Electric Light & Power Co. Electric railways; Aurora Street Railway Co. and Aurora, Elgin & Chicago Railway Co. Telephones; Northwestern Telephone Co. and Chicago Telephone Co.

Water Supply—Artesian wells, by pumping.

Sewerage—Sanitary and storm; crude sewage discharged into Fox River.

Street Cleaning—Day labor; by hand and machine; dirt used for filing.

Street Sprinkling—Private arrangement.

Garbage—Collected by contract; dumped.

Fire Department—Mostly paid; no engines.

Electric Wires—Overhead.

PRESIDENT'S ANNUAL ADDRESS.

BY HENRY G. PADDOCK.

We are again assembled with the happy assurance that this meeting will be of mutual benefit and will furnish the necessary stimulus for advancing our profession along honorable lines of increased efficiency. You have seen from the program that there are many subjects of interest to be considered at this meeting, some of which are of great importance to the general public, as well as to us.

One of the matters of great importance, both to us and to the general public, is the proposed co-operation of the State of Illinois with the General Government in the preparation of a topographical map of the State. The details of this, with the conditions, will be fully explained by a paper on the subject, which is to be presented at this meeting. This is a matter that should be of much interest to all engineers in this State. Those of us who are near enough to make use of the Mississippi Commission topographical maps have found them to be most useful, and have realized what a great inconvenience it would be if we had to do without them. The accomplishment of this work would clearly demonstrate its very great value to any engineer who had general work in Illinois, saving him much time and trouble by giving him absolutely reliable information. Admitting this, it naturally follows that it would be a great benefit to the public. Therefore, we should, both as a Society and as individuals, use our best efforts to prevail on the Legislature to accept the conditions prescribed by the general government.

The subject of roads and pavements is one of the greatest interest. The pavement branch of the subject has been fairly well worked out, owing to the great number of cities that have been dealing with the problem. On the other hand, the subject of country roads has not made the same progress, for the reason that as yet no engineer has devised a plan for a good road, that will come within the means of the land owner; partly owing to his remarkably long frontage. Unless some cheaper material is made available, dirt roads will be the rule until the State contributes a large proportion of the cost for a hard road. In the meantime the engineer can do a great deal toward bettering the condition by directing the making of a proper dirt road. However, under the present laws, the dividing of the territory into such small districts retards to a great extent progress in road making, by reason of the small district not being able to afford proper engineering assistance.

Although one can discover an improvement in road making by comparing the present methods with methods of several years ago, yet the improvement would be much more rapid if the districts were larger, so that men could be put in charge and devote the greater part of their time to the study and the practical working out of the different problems involved.

The discussion of the present improvement laws should be very interesting to many of us, as all classes of cities have discovered serious defects in the law as it applies to them. In the class of cities under 25,000 inhabitants, the law seems to be satisfactory as regards paving, and other improvements of the surface of the streets. But it has been found practically impossible to secure the signature of the owners of half the frontage along the lines of a proper sewer district, for the reason that some portion of the main sewer is almost always very expensive and the property owners along the expensive portion of the main object to signing a petition for a sewer that will not include the laterals and cheaper portions. At the same time, the property owners along the laterals and cheaper portions wait, hoping that the property owners of the more expensive portion will do that work and leave the laterals to be done later without having to share in the cost of the more expensive portion.

The law gives the City Council the right to pass any ordinance for sidewalks without any petition. A sidewalk is certainly a good thing to have, but it would seem that the Council should have the same power to provide for a sewer system where it is needed. Any fair-minded person will concede that a proper sewer system is a sanitary measure that all are interested in, as a badly sewered territory will create a disease-producing condition that is not only injurious to that portion, but to a great extent to the whole city.

The Hennepin Canal, now nearing completion, will give the people an opportunity to see the results of a small waterway connecting the Great Lakes with the Mississippi. Should this be as beneficial as its friends believe it will, its success will be a great help in securing the necessary appropriations from Congress for the investigations necessary to determine if it is commercially practicable to make the Mississippi navigable for the entire season from the Gulf to St. Paul, and to furnish a deep waterway from Chicago to New Orleans.

In regard to membership, each member should make all reasonable efforts to secure new applications, as all societies depend entirely for their success upon the interest taken by their members, and there is nothing which tends more to maintain that interest than the acquiring of new members for the Society.

In retiring from the office which I have occupied for the past two terms, I want to express to you all, my gratitude and deep feeling of the honor you have conferred upon me, and to thank you for the friendly co-operation with me in the discharge of my duties.

FARM DRAINAGE.

BY LLOYD Z. JONES.

After the great loss of crops by last summer's excessive and long continued rainfall and the consequent injury to all industrial branches of the great tree whose root is agriculture, it is, perhaps, a proper time to discuss Farm Drainage, now that the need for better drainage has been made directly evident to farmers.

A gold mine does not create wealth so fast as the drainage of swamp lands which have no present value whatever, and what they will sell for is based only on prospective values. You might easily claim 100 to 200 times increase in value for much of the finest land ruined this year because it could not free itself of water fast enough to save the crops. Drainage squares up fields, prevents ditches, keeps best soil out of creeks, puts best land on the farm into use, makes a healthy country, has land ready days or weeks earlier for spring work, lets fertilizer be taken into the soil, keeps crops growing in wet times, lets roots grow deeper, prevents land from cracking open so deep in dry time, and makes new soil of water-logged ground. These and other advantages can well be claimed for drainage.

Ordinarily one would have to give a list of about twenty reasons for draining farm lands in order to command attention. But the rains of the past summer have convinced every farmer of the desirability of keeping the water from the land above from off his farm, and also the desirability of getting the surplus rain water from his land down upon the land below as soon as possible. All because of that most powerful of all reasons: the want of drainage hurts the pocketbook.

We will discuss tile drainage, as open ditches are very undesirable, and there are no farms but need some tile at least.

First, let us remember that the drainage of each farm is a new problem; no two farms can be tiled just alike to the best advantage.

Second, remember that a tile drain can be made the most permanent improvement a man can build. But there has been more money and tile wasted by doing a poor job of tiling in proportion to the cost, than anything else upon the farm; all because the tile was carelessly laid, or because the ditch digger thought the water might run up hill. I have seen much of this and have bought two farms tiled in this way with the outlet laid up hill. A tile ditch is no place for a man who is good with a spade, if that is the extent of his qualifications.

The meanest job a farmer can undertake is to dig up a choked up tile. To clean a choked tile: Clear away the outlet. Make a long, sharp needle out of an old hay rake tooth. Have a short bend at the top end to pull and turn the needle with. Also get about four lengths of $\frac{3}{8}$-inch round iron rods. Curl up one end like a corkscrew, making the point end of the curl a little smaller, so that it will not catch on the ends of the tiles. Make a wide, flat point so it can dig dirt. Couple the rods together with pump rod couplings. Start the auger up the choked tile from the lower end of the drain, damming up the water so it will follow into the tile to help the auger. The settlings in tiles come loose very rapidly. Work the auger up the tile, its whole length. Then take the needle and push it into the ground the length of the auger, lacking about two feet above the outlet, until you find the tile. Dig out two lengths and get hold of the auger and work it on up the tile another length, when two more tiles are dug out and the auger passed along another length. So proceed until the drain is cleared.

The auger should be small enough to go into a 2-inch pipe, so it will be easy to handle. If there is plenty of water it will clean the dirt out of large tiles very soon, if you keep the lower end free from the dirt washed out.

In laying new tiles, remember that no man can guess a grade. If your land very plainly slopes the grades will not trouble you unless you get them too steep. But if you have a much better quality of land where there are wet places or ponds, and several of these may need to be connected to the main tile, the first thing to do is to get a surveyor with a level. If he is competent he will cost you $5 to $10 per day and expenses, but it will be the cheapest labor you can employ on the job. Find the lowest point on your land and look below onto the next farm and see what is there. If you see a big open ditch, it is well. But if the land is a wet slough you had better go and interest your neighbor, and go down across his land looking for some place where the water runs down hill, so a clearance for the tile drains can be found. If your neighbor is not agreeable, a suggestion of the amount of water you expect to turn upon him may make him see his own interest. If he does not, you must pour the water from your farm upon his land at the top of the ground at the lowest point of your land, if you cannot get a drainage district established. A drainage district drains large tracts of land, regardless of neighborhood notions. If your land is too near level to get your tile into the ground and outlet at the lowest place, you must wait.

If you can drain the farm, begin at the lowest place and drive a stake each 50 feet, up across the land. Follow the lowest general lay of the ground up into all the wet places in the land. Some of them may naturally drain some other way, but if you can get them all into one system of drainage, it is better to do so. Take the level from the lowest place to all the stakes (and bottom of the cellar), and find how much above the outlet the lowest stake in the farthest pond is. You now have three fixed conditions. The outlet, the distance, and the height of the bottom of the farthest pond. The other two conditions, the depth to dig in the pond, and the grade, can be varied to suit conditions. If the last pond is deep and the water readily comes toward it, the tile need not be laid very deep, perhaps a foot below the top of the ground to the top of the tile. This latter condition is advisable only when it will save much deep digging in the higher ground through which the pond is drained. The balance of the fall left after the depth of digging in the upper pond is fixed, is to be apportioned equally along the whole length of the drain and each stake marked just how deep the ditch is to be dug at that point. The grade may be changed to fit the ground. The bottom of some other ponds may be too low to fit this grade. These things are all shown on the surveyor's record book, so that he will know which pond or wet place controls the drain, and so more depth may be given in the other ponds if it does not cause deep digging between ponds. The lower length of the tile may be laid perfectly level, if desirable. This will get more depth for the upper portion of the tile and its branches, in level lands, and also enable the lower end to be lowered into the ground to meet the upper end of the neighbor's tile when he tiles his farm. A description of sizes of tiles, where laid, the length of each size, and location of all branches, should be written in the farm records for future reference, as it may be needed in 50 or 100 years.

Having decided to drain, the next question is how large tile to buy. There are several governing conditions.

First, the lay of the land, whether rolling or flat. The rolling land delivering the rain water near tiles much sooner than flat land and larger tile is needed, less drain will need to be dug.

Second, the kind of soil, varying from sand and gravel to the solid blue clay and hardpan. Sandy land needs larger tiles and the drains far apart, while blue clay and kindred soils need the drains close together and smaller sizes of the tile will do as well, because water travels much slower in such land.

An idea of the soil can be best obtained by digging a pit 4 or 5 feet deep where the land is wet or covered with water. Carefully tramp the earth thrown out clear around the pit, to keep away surface water, and then note whether the subsoil water fills the pit quickly or very slowly. If slowly, you will want more drains and smaller sized tile. Owners of blue clay and hardpan lands will receive some very pleasant surprises if they can tile enough to keep down the subsoil water so the land can freeze deeply and break up the subsoil. Do not watch the surface water around the pit only to see that it does not leak over into the pit, as the whipping of rain and the wind waves of the ponds have a tendency to make the ground watertight.

Third. Grade—Tiles laid on steep grades carry water very much faster than the same size laid level or nearly so. Practically four times as many inches fall in 100 feet carries twice the amount of water in the same size tile. A 4-inch tile laid on a 3-inch grade is supposed to carry 50 gallons of water per minute, but the number of gallons depends upon how much head of water in the soil or pond is driving the water out of the tiles. If lower lengths of drains are packed with clay so as to be air tight, and no crawfish holes go down to the tile, and also if the lower end outlets under water, then the volume of water discharged must be replaced by water or air from above, and so a suction is caused which helps to increase the flow. But if the land along the upper lengths of drain is storm beaten, so water and air cannot go down into the soil, your tile will run water like a barrel without a vent or an inverted bottle with a small neck.

A piece of tile drain in my neighborhood about a mile long was acting badly. When a man owning the upper end dug down to see if the tile was choked up, the water immediately began to rush out of the lower end and the land soon began to dry.

Fourth. Before you buy tile go and see how many acres of your neighbor's land drains upon yours. If you find 160 acres drains to you all at one place, you will buy 12-inch tile to put in at the fence line between your farms and increase the size to 15 inches where it leaves your land, if you drain 160 acres. I warn you not to attempt to carry water from his large tile through a small tile of yours, for if there is a good head of water above it will heave your small tile clear out of the ground even if 5 feet down. This break may occur where the two tiles join, but more likely down along the small tile with the accumulated head of water at a partially choked place.

No man can tile to carry all the flood water of storms, but he should tile drain with the idea of getting rid of the water in a day or two, before it has lain on the crops long enough to sicken or destroy them. A 3-inch tile should drain four or five acres, and in rolling ground it might drain 40 acres. The rolling ground throws off the storm water in a quick flood, leaving the tile to care for the wet land in the bottom of the hollow.

A safe estimate for a nice level farm of 160 acres, all draining to one outlet, would be 12-inch tile for the lowest length with the branches made of the following list of equal sizes:

One 12-inch tile equals two 9-inch; three 8-inch; four 7-inch; five 6-inch; eight 5-inch; sixteen 4-inch; and thirty-two 3-inch tile.

Doubling the diameter increases the capacity about 5½ times, not four times, as according to school books, for water runs faster in larger volumes. Connect two 3-inch tiles to a 4-inch tile. A 4-inch and a 3-inch to a 5-inch; and an 8-inch and a 5-inch to a 10-inch, etc.

Rule: Square the diameter of tile of each branch and put in, below, the sized tile whose diameter squared makes as much as or a little more than the sum of the squares of the two smaller tiles.

The red brick tile are just as good as the hard glazed tile. The well burned brick tile will last a thousand years if well laid below frost and the glazed tiles will break all to pieces if laid so they can freeze full. Much money was spent for sewer pipe to make road culverts in a certain township (apparently a perfect culvert). They froze full, split to pieces, and had to be taken out. Get samples of the same trade size from different tile factories, stand them on end and count the cups full of oats to fill each. Some makes of tile are as cheap at $50 per thousand as others are at $35 per thousand. About $200 will put 1½ miles of 3-inch, 4-inch and 5-inch tile into a good eighty-acre farm.

Before deciding on a plan for a system of drainage for a farm or a drainage district, it will be necessary to know the kind of subsoil the drains will pass through before the grades can be decided. The grades may be level, medium or steep; of these the medium is best, the level not so good and the steep grade is the least safe. All lands having firm subsoil of clay or gravel can be safely drained with any of the kinds of grade, but there are other conditions which may control the grade, viz., the kind of subsoil and the amount of fall. If a lump of subsoil will dissolve when placed in a dish of water it means the tile must be laid with little grade. Sand, quicksand, some of the clays, and the soft sediment in swamp lands may be mentioned as lands where tile must be laid on a dead level or on grades of 1 foot to 5 feet per mile. The reason for this is that the water in the tile on steep grades has so much current that it causes little swirls of water outside of the tiles at bad or broken joints. This, acting on the quicksand or sediment soil, soon digs out a cavity, the end of a tile drops and immediately there is trouble. The bad place (probably shown by water coming to the top of the ground) has to be dug out, and perhaps the whole line of tile must be put on a grade nearer level. Even in good tiling land care should be taken to clean out little sand pockets and fill them with clay, if there is danger of the sand getting into the tile so as to drop one or more out of line. Some old patriarch of a crawfish may establish himself under a tile in solid ground and dig so large a hole as to drop a tile out of grade; but this trouble is easily repaired when found out compared to the trouble a choked tile in soft soil causes. Larger sized tiles are used in soft lands when laid level, or nearly so, than where there is a good grade. The larger size lets through a given volume of water with less speed, so as not to disturb the soil.

The other case requiring level or nearly level tiles is where there is a little fall from the low place at the upper end of the drain to the outlet, as for instance, some pond whose bottom is but a few feet above the outlet place, perhaps half a mile away. If the surrounding farming land needs to be drained to this pond, it is desirable to lay the tile on a dead level from the pond to the outlet, as most crops will do better with 4 feet of soil not water logged than they will with less. One would not think of giving a fine, large apple tree less than 5 feet of soil to grow in, and yet orchards of young trees are sometimes seen planted nearly to the water of shallow ponds in level lands. In a dry season the roots go down, while in a wet season the roots are drowned, and no trees are seen. Hence if the lay of the land requires the tiles to be made level or nearly so, lay them that way. Put a sump in at the lowest place in the pond and never fear that the water will not run out. When there is a heavy rain to fill the tile at the pond, the water will run out just as fast upon the level tile as if the tile came to the top of the ground in the pond and had a down grade all the way to the outlet.

Every time I have said level tile I have meant level. Not some parts level and some parts towards the outlet up hill; water will run up hill in a new drain, but as soon as the pressure is off the water drops the earth it is carrying and it will not be long before the tile is choked with dirt. Medium grades for tiles are such as have from 5 to 30 feet fall per mile. A grade of 1 inch per rod, being 26 feet per mile; three-tenths of a foot fall per 100 feet, 17 feet per mile, is a desirable grade where the lay of the land permits. It is steep enough to readily dry the land and level enough so the water will not loosen the earth in good tiling ground.

Land suitable for medium grades is much easier drained, as the grades can be made steeper or nearer level to suit the surface of the land and to hurry along the water in places where it is not desirable to put in a larger sized tile. Steep grades are sometimes necessary, as when an area of fine upland has a number of wet places or shallow ponds which can all be collected by a system of drains on easy grades toward some hollow leading off to a creek. The hollow being good farming land with no ditch it is not desirable to let water from the tile run upon the land, so tile on steep grades must be put in down the side hill into the hollow and down the hollow to the lowest land line, saving all the waste wet land possible and yet stopping far enough from the fence line to build a fine watering place for stock. I say "build," advisedly, as work must be done to protect the outlet from stock and the earth washed down by rains. In getting down off the level land into the hollow, grades may need to be as steep as 5 to 10 feet to 100 feet, in which case the tiles must be laid with great care. No imperfect tile should be put in. The bottom of the ditch should be cut out just the size and shape of the bottom half of the tile so there will be no space outside the tile for water to run in. No sudden changes of grades or courses should be made. All joints should fit closely or be covered with broken pieces of tile, and the first filling put in should be well packed. In an important job, the steep grades should be laid with sewer pipe, so that the bell ends will keep the tile in line.

In bad tiling land, where common tiles are used, steep grades can be avoided by using as much grade as the soil will stand, and putting in wells so the water may fall out of one tile near the top and go into another several feet lower near the bottom of the well. Three or four large size tile make a good well and protect the fall. These wells or peep holes without change of grade are nice to have in any tile system where they are not in the way of the plow. The cover can be taken off and the owner can see what is going on below. They are useful to locate faults, for if the lower one of the two wells shows empty or a small stream and the one above is partly filled with water it shows a fault between, which must be dug out, and you do not need to wait until much damage is done before you find it out.

When the lines of the tile drain can be determined by the lay of the land before the levels are taken, it is best to open out the line of the ditch with a team and plow in cultivated lands and grass land not too wet to plow. Several furrows can be plowed each way leaving a wide, deep, dead furrow, in the side of which the grade stakes can be driven. This is the easiest possible way to get the first six to ten inches of the ditch dug, and in land filled with strong roots of slough grass, it saves a large amount of hard work with a spade and enables the remaining depth of the ditch to be easily dug.

In wet ground filled with grass roots so that the digging is very difficult with a spade, a long, narrow-bladed hay knife is the best tool with which to start the ditch. The hay knife being pushed as deep into the ground as possible along each side of the ditch cuts off the grass roots and parts the soil so the ditch digger has one side of each spadeful free. Like all other trades, there's a trick in the ditch digger's trade, which is to always take out a three-cornered piece of earth on the spade, turning the spade alternately to right and left, so the side of the spade nearest to the center of the ditch is in sight as the cut is made and the other side of the spade is deep back in the soil. It is easy digging for the man and but little dirt gets loose and falls back into the ditch. The ordinary flat spade has no place in a tile ditch. It is bad enough to dig square holes to put round posts in, but it is worse to dig a ditch with a flat spade, as it will not hold the dirt it loosens.

The tools needed on an ordinary tiling job are: A long handled, round pointed mining shovel, having an air hole drilled through the middle so that stiff mud can let go; a long and a short ditching spade. Sometimes one or the other will just reach down to grade on the last cut. For tough clays and sticky top soil, nothing equals the three-tined skeleton spades. They are easy to push and there is so little for the stiff mud to stick to that they always scour and a spadeful always lets go.

A tile scoop or cleaner is needed to get the loose dirt out of the ditch. Probably the best you can get will be made from an old scoop shovel by bending it like a sunbonnet. Rivet in a bent shank so the scoop will hang under like a hoe. Fasten the shank to the large end of an old buggy shaft, put a D handle on the small end, if you have one, then you will have a scoop that will take up even the loose dirt under water that the store scoop will not lift. This tile scoop can be spread out to fit the curve of a large tile or pushed together to fit small ones.

For all soils not gravelly or stony, make all the above tools so sharp that they will shave a board. For all top work in easy soil, use the round-pointed shovel. No other hand tool will so easily remove so much dirt in a given length of time as the miner's shovel.

Being ready to dig, the next question is how to keep the bottom of the ditch on the grade line, for this is the particular part of the whole job of digging. If the ditch gets too deep (as it naturally will if there is no check on the digger) the line of the tile will be broken, and if no other damage is done the water carrying capacity of the tile will be reduced. You can lay two tiles on a box end to end, but out of line, and look through them and you will see the opening for water much reduced. Hence the need of much care to get the line of tile straight on the grade.

The common method is to stretch a fine wire or cord above the center of the ditch supporting it every 50 feet, so it will be just so many feet above grade, generally 7 or 8 feet. A pole of the same length is used to try the depth of the ditch as it is dug. This would be a perfect method if it was possible to stretch a string or wire straight, but this never has been nor ever will be done. The tile will be at the grade at each of the supports and too low between.

A better method is to take a bundle of lath, and drive one each side of the ditch at each grade stake. Then, if the grade stake says dig 4 feet, nail a third lath across just 2 feet above the ground, making it level by means of a hand level. Do this at each grade stake, nailing the lath across just as much above the ground as the difference between the depth to dig (marked on the stick) and 6 feet. If the surveyor has done his work correctly, you can then sight over the top of a lath down along the line and every lath will just come up to the line of sight. This is a good check on the surveyor's work. If any lath is too high or too low, bring it into line and you are ready to dig. You can use these lath on a small job that is plainly down hill, so that you will not need a level. This will get you a perfect grade over rough ground. By using these level lath or longer strips, a grade can be carried around a curve with no instrument but the eye and a pocket level.

In draining soft, spongy or peat lands, long stakes should be driven at each grade stake, so the lower end will be in solid soil and the top end just at the level of the ground. Then if the water runs into the ditch so fast as to lower the top soil the grade will not be lost. Some lands may have soil more or less firm on top, but at the bottom of the ditch there may be sand or soil that will not stand and hold the soil above. In this case the grade stakes and the long stakes should be set far enough away from the line of the ditch that the sides will not cave in and displace them. If the banks will not stand, boards should be driven down on each side of the ditch and braced across the ditch. The tile laying should follow close behind the digging, giving the banks little time to crack and the water little time to create passages towards the ditch.

If the sand runs in so that it cannot be stopped, use sewer pipe tile, and make an iron box without top or bottom, having one end and two sides. This box will be a little longer than a tile, and will have a brace piece across the open end and a handle at the other end. Drive this box down ahead of a tile; clean out the box; lay a tile; pull up the box, and move ahead a tile length. Sand in the tiles may be flushed out by putting water into the box. This box will only be needed in the worst kind of work.

When the tile drains extend across two or more fields, a sump should be placed in the drain at the lower side of each field. These will let in the water of heavy showers long before the tiles will fill by water soaking down through the ground. Water runs off grass lands much faster than off plowed lands, and a sump will help to prevent the ditching and washing away of the soil of a plowed field by water coming from grass lands above. If these sumps are made of large sized sewer pipe set vertically, and are put down two or three feet deeper than the drain, so that the water will enter through a hole on one side and go out on the other side, a pail can be let down and water drawn for men or stock.

Most sumps have been failures, being made of wood, and nearly always out of order. Probably the best arrangement is a strong casting like the grate of a round stove. This can be placed in the bell of the top pipe of the sump. It gives large water capacity and can only be moved by a man. Enough bricks or stones should be loosely piled over the grating to prevent it from being covered and clogged by the weeds and pieces of cornstalk that are washed over it by flood waters.

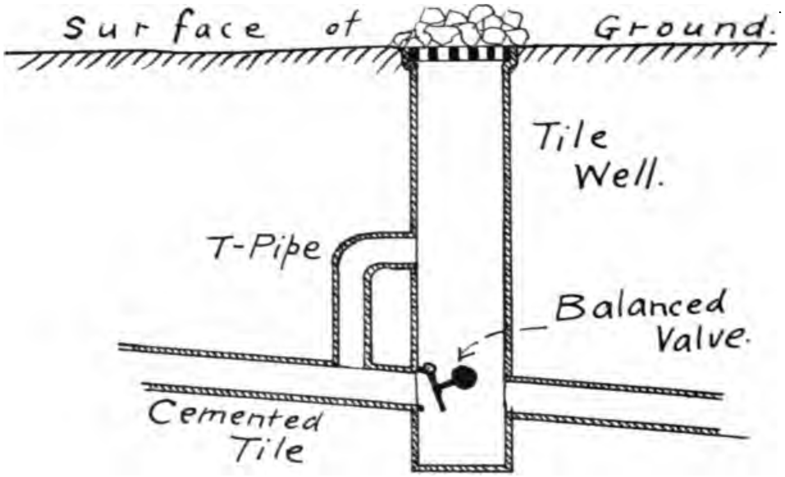
Cover the tiles in the ditch with the best dirt from the ditch, packing it down tightly upon the tile. After this, if the drain is in plowed land a long evener can be used and the earth plowed back into the ditch, care being taken to heap the earth above the tile so that a heavy rain will not wash out the ditch before the earth has settled.

It is well to let the small boys ride the horses over the line of the tile, so as to pack the ground. Ditches in dry ground can be quickly filled with a scraper and team, connecting the double-trees with the scraper by a length of rope or chain. In wet solid ground or sods, use a manure fork when filling by hand. In sections of country where there is much level land to be drained, the steam ditching machines can be profitably used for digging the trenches in all good digging ground.

We are accustomed to hear nothing but praise for drainage. In my experience I have found but one fault with tile drains; namely, that the drain does not stop working when it has done enough. If the rancher in the arid lands can pay $1.50 per acre, per year for water for irrigation purposes, it seems that some plan of check valves should be arranged to check the waste of subsoil water from tiles when the land above them is in fine condition for cultivation and plant growth. Lands which most need drainage and have the least value without it are the lands which can not resist drought.

Their richness in humus acts to their disadvantage, allowing the ground to dry and crack open, even below the tile in dry seasons. The farmer, like Alexander, has "no more worlds to conquer." The great increase in the price of land warrants improvements not to be thought of for cheap lands. It will be in order for drainage engineers to devise some plans to save subsoil water. I suggest the following:

A series of invisible dams in the soil made by laying a length of tile with cemented joints varying in length according to the ease with which water passes through the soil. This tile to have two outlets into a tile well; the lower one on grade, the upper one to be made by putting in an inverted T tile, with the stem to rise two, three or more feet above grade. The lower opening to be closed when the soil is in good condition by a plug or valve balanced to resist the few feet of head. This is shown in the accompanying sketch.



DISCUSSION.

MR. E. E. R. TRATMAN: I would like to ask Mr. Jones in regard to draining land; has a man the right to throw any water on to his neighbor's land?

MR. JONES: He can turn off all the water his land produces at the ground level; not by suddenly turning loose a large body of water upon his neighbor's land, but by tiling out the ponds when dry so that they do not fill again.

PRESIDENT: I know of a case where a man owned a large tract of land that was level and where, in any reasonable distance, he could not get to a point where he could have an outlet. He put in a system of tile drainage on that ground, and then put in a wind-mill and a suction pump, such as is used to pump out cellars. Of course he only had to raise the water enough to throw it over a dam and let it go, and he succeeded in raising some very fine crops. It was what you would call a good sized wind-mill and was sufficient to clear 160 acres of land.

MR. GEO. BROWN: In case there is a natural waterway, you can drain all the water off in that way at the ground level, but this question of a natural water course is one of the most difficult questions there is.

MR. JONES: I have seen cases tried in court and they could not prevent a man from turning all the water he wished upon his neighbor.

PRESIDENT: But you have to throw it off at the surface of the ground. The water courses in law are a little different. You can cut through a pond which overflows in a certain way. You can cut through that and let the water off and very rapidly, but you have to use a little judgment and not flood any one.

MR. J. M. MCNABB: The common law is that you can discharge all the natural water at the ground level when you do not bring in new water. You must not bring in water from another channel, that would be a damage to the man below you.

MR. CLARK: I think Mr. Jones is wrong a little about the grade. The tile may be laid level. I laid a tile level a mile and a half and the current and volume of discharge was all right, and this is very important down on the Kankakee marsh where for an area of nine miles wide and 68 miles long the land is almost a dead level.

OPEN DITCH DRAINS.

BY P. C. KNIGHT.

The heavy rains of the year 1902 demonstrated that we have quite a good deal to learn in land drainage. Very few of the open ditches were of sufficient capacity to protect and save crops on low and comparatively level lands from even partial destruction. In working out formulas for drainage, in works on hydraulics, apparently little consideration has been taken of the height of the perimeter of the valley of which the ditch acts as a drain. The variation of this, the slope from the divide, together with the width of the valley, form almost limitless combinations which must be taken into consideration in order to arrive at a perfect conception of a ditch that will drain thoroughly the low lands lying along the bottom of the valleys.

We often find it to be the case that the upper part of the valley or drainage area is composed of rather abrupt slopes, in comparison to the slopes of the bottom land, which have fall enough to form for itself sufficient drainage for the water which runs off the surface. I include under bottom lands, the land for which artificial drainage is a necessity before it can be used for agricultural purposes. The length of the valley must also be taken into consideration, even if the engineer does not have the whole drainage area in his district. I find that all formulas for the computation of drainage that have come to my notice are made for computing drainage areas of nearly uniform slope. While I do not think that engineers have been altogether governed by these formulas, still I am inclined to think that a great many have been to some extent misled by them; judging from the results.

Unfortunately drainage engineering has been, to a great extent, considered a simple proposition, and I have often found men of other professions assuming to act as drainage engineers, mostly attorneys-at-law and doctors of medicine: I find many men of these professions who will make a statement like this: "Why, yes, I studied surveying when I went to school," and I do find quite a good many of these gentlemen who have been acting as drainage engineers. These undoubtedly, if able to compute their ditches at all, did so from the formulas of works on hydraulics.

However that may be or in what manner whatsoever the sizes of ditches were arrived at, either by lawyers, doctors, county surveyors or engineers, the fact remains that a great many of their ditches proved very deficient in 1902, which year was noted for the amount of rainfall: to the knowledge of the writer the rainfall in several parts of the State of Illinois exceeded the average rainfall by from 11 to 16 inches, which is about a third more than the average. I may digress a moment to explain that this confutes the theory of the people who claim that on account of drainage this land of Illinois will in a few years become an arid desert.

I now give the rainfall of ten days of July of last year at a point near a drainage district of which I am the engineer.

	Inches of Rainfall.
July 14	0.11
July 15	0.00
July 16	2.41
July 17	0.72
July 18	2.00
July 19	0.44
July 20	0.01
July 21	0.00
July 22	2.55
July 23	0.03
Total	8.16

This is a great deal of water to fall in that length of time. Yet to save farm crops, this must be taken into consideration, and now that land owners have seen the production of swamp lands, after drainage, nothing short of perfect drainage will satisfy them.

The water precipitated on drainage areas of narrow valleys, say 2 miles in width, will get to the main drainage channel in very much less time than it will from off a valley, say 8 miles in width, in spite of what engineers may do to help out the larger district. This becomes a large factor in estimating the main drain of the district to be drained; which is generally the first consideration after a drainage district is formed. It is seldom the case that an engineer is given a free hand at that time to make a plan for the perfect drainage of his district, each individual owner preferring to drain his own tract of land according to his own ideas; although I will say that now they nearly always call in the services of an engineer to help them out. At some future time I hope to be able to give some reliable information as to how the size of drainage ditches may be computed, but am not prepared to do so at present.

I have found that the run-off of a valley having an area of 324 square miles (being nearly 40 miles in length, 8 miles in width, and with a perimeter which has an elevation of about 100 feet above the bottom land), was carried without overflow by a channel having a bottom slope or fall of 2.28 feet per mile and a cross section of 650 square feet or about 2 feet of area of cross section to one square mile of drainage area. In another case, it took a channel having an area of cross section of 94 square feet, with a fall of 1.1 feet per mile, to carry the water of a valley of 8 square miles (approximately 4 miles in length by 2 miles in width), the perimeter of which had an elevation of about 20 feet above the bottom land. This shows that the problems of drainage are not easy.

THE PURIFICATION OF WATER FOR SMALL CITIES.

BY CHARLES B. BURDICK.

A man high in the government of the chief city in the United States has said: "The public water supply transcends every other subject and object of municipal government, in importance and immediate effect upon every human being of whatever condition of life; and it should therefore have precedence in municipal affairs and the apportionment of funds for maintenance and improvement." That this is true there can be no doubt. Without water no life can exist. Any subject that affects the public health is of prime importance, and there is probably no subject, with which municipalities have to deal, which so vitally affects the public health as that of water supply for domestic use.

There is no such thing in nature as an absolutely pure water; that is, pure in the sense that it is a chemical combination of hydrogen and oxygen without admixture of some foreign substance. The solvent property of water is great. The rain, as it falls from the skies, dissolves and washes from the atmosphere impurities of various kinds, the vast majority of which are, however, harmless. Upon reaching the earth, a portion of the rain is absorbed by vegetation, a portion flows off over the fields and into the water courses, and a portion sinks into the ground, to appear at the surface again through springs and wells. Throughout its travels, this water is constantly undergoing more or less change. That portion of the rain which flows off over the fields, picks up particles of the soil and other substances which render surface waters usually more or less impure and at times of flood very unsightly. That portion of the rain which sinks into the ground, may travel for miles, often hundreds of miles through the porous strata underlying the earth's surface, during which time it is robbed of most of the foreign matters it has picked up upon the surface of the earth, and dissolves from the rocks and sands through which it passes, salts and mineral substances which may or may not be detrimental to its use for domestic purposes.

Practically speaking, a pure water, as the term is applied to a public water supply, is a water that contains no substance deleterious to the public health. In addition to being free from the germs of disease, it should be of reasonable softness; that is, the dissolved mineral substances should not be in such excessive amount as to injure the delicate linings of the human digestive organs, nor should they be in such amount as to make the water unfit for use in steam boilers, for manufacturing, or for other domestic uses. Not only should the water be pure and soft, but it should be clear. While it is true that a turbid water may not necessarily contain the germs of disease, it is also true that a water unpleasant to the sight will always be, and should be, regarded with suspicion; and while it may perhaps be, and probably is, less impure than the clear water obtained from the dooryard well, the majority of people will not believe it, and will turn to the clear water even though it be reeking with invisible impurities.

Public water supplies may be divided into two classes. First, ground waters; these, as the name implies, are waters taken from beneath the surface of the earth through wells or springs. Second, surface waters; from streams, ponds and lakes. Both waters are from the same original source, the clouds.

As a general rule, deep ground waters, if chemically suited to domestic use, do not require artificial purification. It is also a general rule, especially in these prairie states, that surface waters do require artificial purification.

Exceptions to this last rule are some of the large and deep lakes which have become purified by percolation through the soil, or from which the foreign matters have been deposited or oxidized through long periods of rest. There is one other class of surface water that, in some cases, can safely be used for domestic purposes without purification; namely, water obtained by impounding, or collecting the rainfall upon areas of land. This is really a means of collecting a surface water before it has become seriously polluted. Such method of collecting water, is, however, a means of last resort; it necessitates the municipality or company supplying the water, owning and policing the watershed in order that the supply may not be polluted. The cities of New York and Boston obtain their supplies in this way.

Numerous processes have been devised for the purification of water. There is, however, only one process that is adapted to the needs of municipal water supplies, and which has stood the test of practice. This process is filtration, preceded in most cases by sedimentation.

It is a well known fact that a turbid or muddy water, if allowed to stand for a time, will deposit a portion of its suspended matters. The length of time which is required for a water to clear itself in this way depends upon the quality of the sediment held in suspension. Large and heavy particles are deposited quickly, while the small and finely divided particles will remain in suspension for many days. Before filtration became well known in this country, sedimentation was largely used in improving the water supplies from our Western rivers and is largely used to-day. It is, however, not to be considered as more than partial purification.

The question may be asked, does this preliminary process purify or simply clarify the water? In answer, it may be said that in a general way, the bacteria or germs which the water contains are removed in about the same proportion as the suspended matters. The suspended matters in settling to the bottom of the containing reservoir, carry down a portion of the bacteria.

Water is partially purified by sedimentation in two ways: First, by absolute rest; and, second, by continuous flow. In the first process, absolute rest, the water is pumped into settling basins and allowed to remain until the desired result is secured. By this method it is necessary to have two or more basins in order that the water from one may be used, while the water in the others is undergoing purification.

In the continuous flow method, the water is being constantly pumped into and constantly drawn from the settling basin or basins, a constant slow flow being maintained from the inlet to the outlet. Experiments seem to indicate that the efficiency of absolute rest is somewhat greater than continuous flow; that is, in a given length of time more sediment will be deposited with absolute rest than with continuous flow, even though such flow be extremely small.

On the other hand, it will usually be found, in small water works, that with a given outlay of money in settling reservoirs, somewhat better results can be obtained by continuous flow than by absolute rest. This is due to the fact that in continuous flow the whole reservoir system is in use all the time, whereas, with absolute rest, a portion of the system is always cut out for filling and settling.

The amount of purification effected by plain subsidence depends upon the character of the water. The character of the suspended matters is also an important element. Experiments at Cincinnati on Ohio River water, indicate that 24 hours rest of moderately turbid water will deposit about 60 per cent. of the suspended matter. After the first day, deposits are extremely slow; in the same experiments it was found that only 76 per cent. of the suspended matter had been deposited at the end of the fourth day. Higher results than the above can be obtained on most of the Western rivers, the Ohio River being particularly difficult to purify, owing to the extreme fineness of the suspended clay.

Sedimentation is greatly assisted by the addition of a coagulant such as alum, to the water before entering the settling basins. It has been said that where plain subsidence is a matter of days, subsidence with a coagulant is a matter of hours. A shorter time of subsidence reduces the necessary outlay in settling basins, and on the other hand the addition of a chemical to the water, increases the cost of operation, so that the proper capacity of the basins, and the amount of chemical which it is desirable to use, if any, is a matter which must be decided for each particular case. That arrangement is the best in which the sum of the operating cost and the interest on the investment amounts to a minimum.

A chemical to assist in sedimentation has seldom been used to the author's knowledge except in plants where sedimentation is succeeded by filtration, although there is no reason why it should not be applied at times in many instances where sedimentation without filtration is used.

Water filters as applied to public supplies to-day may be divided into two classes: the "slow sand filter" and the "mechanical filter." In both cases, the filtering material is sand and the difference lies in the form of construction and the mode of operation.

A slow sand filter, consists of a water-tight reservoir 6 or 8 ft. in depth; the bottom made pitching toward valleys in which are laid a system of drains. The whole bottom, including the drains, is then covered with a thin layer of broken stone or coarse gravel; upon the coarse gravel is laid one or more layers of fine gravel, a few inches in thickness, and upon this is placed from 2 to 5 ft. of filtering sand. In operating, the water is admitted to the top of sand bed, whence it passes through the sand and out through the under drains into the clear water reservoir. In England such filters as these operate even in winter without a covering of any kind. In this country in climates such as the New England and Middle States, Pennsylvania, Ohio, Indiana and Illinois, it is necessary to provide a covering for the beds.

After a slow sand filter has been in operation for a period varying in practice from a few days to five or six weeks, it must be cleaned by scraping an inch or two of the accumulated material from the surface of the bed and then smoothing the surface with a rake. At intervals of about one year, or whenever successive scrapings have materially reduced the thickness of the bed, clean sand is added to bring the bed to its original thickness.

The fact that an impure water causes disease, and hence the desirability of purifying supplies for domestic purposes, was recognized at a very early day. As early as 440 B. C. we have mention of the purification of drinking waters by boiling and filtering; and the processes of sedimentation and filtration were known and used by the Romans.

The first slow sand filter of modern times was built in London England, in 1829. Owing to the good results obtained from this filter, the filtration of all river water supplied to London was made compulsory in 1855. Within the last 15 or 20 years, the use of sand filters has become almost universal throughout Europe, wherever surface waters are used. The first slow sand filter in the United States was built at Poughkeepsie, N. Y., in 1872 and is still in operation. Only one other filter of this kind was built until within the last few years. According to the census of 1900 there are now 21 slow sand filter plants in operation in the United States, and 141 water works purify their supply by means of mechanical filters.

Mechanical filtration, an American process, differs from slow sand filtration primarily in two ways: First, that before filtration, the water is treated with a chemical coagulant; and, second, that means are provided for washing the sand without removal from the filter beds. Through these means a much higher rate of filtration per square foot of the sand surface is secured. This increased rate of filtration enables a much smaller area to be used in purifying a given quantity of water, and makes possible the use of tanks or tubs for enclosing the filtering material, while large masonry enclosed vessels or reservoirs are required in slow sand filtration. The tile underdrains in the latter are replaced in mechanical filtration by iron pipes into which the filtered water enters through slotted or perforated brass strainers, these being made necessary due to the higher velocity of water which, if applied to a slow sand filter, would cause the filtering sand to pass with the water into the tile underdrains.

The rate of filtration through "slow sand filters" is from 1,000,000 to 3,000,000 gallons per acre per 24 hours, while in "mechanical filtration" a rate of 125,000,000 gallons per acre per day is practicable. Or to put it in another way, where one acre, or an area 208 ft. by 208 ft., is required in "slow sand filtration," the same work can be done with "mechanical filters" in an area of 525 sq. ft. or in three circular tubs or tanks 15 ft. diameter.

The chemical coagulant above referred to, and without which, good results with the high rates of filtration per square foot of sand bed could not be secured, consists usually of alum or sulphate of alumina, dissolved in clear water. This solution is applied through suitable pipes to the unfiltered water and enters into a chemical combination with the compounds of lime found in all natural waters. This chemical combination forms a precipitate, white in color and somewhat similar in appearance to curdled milk in a cup of coffee, although the particles are much more finely divided. These particles being slightly heavier than water, do not float, but tend to settle to the bottom of an enclosing vessel upon being allowed to stand for a sufficient time. This product of coagulation, or coagulum as it is called, upon passing to the filters, is easily caught by the surface of the sand, and of itself forms a scum upon the surface of the sand bed, extremely fine in texture, which is useful in arresting impurities in the water which would otherwise pass through the sand filter and greatly decrease its efficiency as a purifier.

The ability of a water to make use of the alum or other coagulant, in this way, depends upon the quantity of carbonate and bicarbonate of lime and magnesium in solution in the water. Different waters varying in this ability and waters from the same source varying at different seasons of the year. As a general rule, at the stage of low water in a river, the amount of lime per gallon of water is greater than at flood times; as during low water, the river is largely fed by ground waters which are high in lime, while at flood times the rain water predominates. During ordinary stages of a river there is usually three or four times the necessary quantity of lime present in the water to utilize the quantity of coagulant desirable to add. At times of extreme turbidity, which are coincident with high water stages, it is necessary to increase the quantity of coagulant employed; and with some waters, a condition exists where, at times, lime should be added to the water to satisfy the coagulant. It is wise in all cases to provide for the addition of lime as, when added with the alum, it generally facilitates coagulation during stages of extreme turbidity.

The report of tests made upon Ohio River water at Cincinnati, state that, under average conditions, the water is capable of satisfying 6½ grains of alum per gallon of water, whereas the annual average amount of chemical required is estimated at 1.6 grains per gallon of subsided water.

One of the companies engaged in the manufacture of filters has recently perfected a device for utilizing iron as a coagulant in place of sulphate of alumina, or alum. It has been demonstrated that this process, under certain conditions, will effect a saving in the cost of coagulant, over alum, of 50 or 60 per cent. The filter company has not yet, however, reached the point where it is advocating the iron process in plants of 1,000,000 gallons capacity or less, the first cost of the necessary apparatus being approximately as large for a small plant as for a plant of several million gallons capacity.

In practice the water, after treatment with a coagulant, is allowed to rest for a period of from half an hour to three hours before passing into the filters. By this means a portion of the coagulum (the substance being slightly heavier than water) settles to the bottom of the enclosing vessel or tank and carries with it the coarser of the suspended impurities. This sedimentation with coagulant, is a very necessary preliminary step to the purification, by filtration, of a turbid water.

The amount of coagulant necessary to produce the best results, depends upon the character of the water to be filtered, varying from a fraction of a grain of the dry chemical to 5 or 6 grains in extreme cases per gallon of water. The annual average in most plants where a uniformly high grade of purification is attained, is not usually found to exceed 1 or 2 grains per gallon.

Mechanical filters may be divided into two general classes: the gravity filter, and the pressure filter. Both types are extensively used and, when properly operated, give equally satisfactory results. The particular type which should be used in any case depending upon cost and expense of operation under peculiar local conditions.

A gravity filter, as it is usually built, consists of an open tub or tank, constructed of steel or wood, 10 to 15 ft. diameter and 6 to 8 ft. deep. Upon the bottom of the tank are laid the iron collecting pipes, connected together and passing out through a tight connection at the side. Into these connecting pipes are screwed the brass strainers and the space between the pipes and strainers, up to the level of the perforations or slots, is then filled with concrete, making a hard floor. The tank is then filled to a depth of from 2 to 4 feet with the filtering sand, which should be clean, hard, and reasonably uniform in size. The size of the grains plays an important part in the successful working of the filter, the most common practice being to use a sand somewhat finer than the best grade of mortar sand. Local sands will sometimes be found suitable for use, but generally it will be found advisable to import the filtering material from one of a number of places where special filtering sand is mined. Crushed quartz is also used as a filtering material.

In operation, the water is admitted to the top of the filtering tank and spreads out over the top of the sand to a depth of from a few inches to two feet. Thence it passes downward through the filtering sand, through the brass strainers, into the collecting pipes, and thence through the outlet pipe into a reservoir provided for the filtered water. This reservoir should be covered, to shut out the sunlight, which has an injurious effect on filtered water, and further to prevent contamination from outside sources.

The amount of head necessary to operate a gravity filter at the usual rate of flow, being the vertical distance between the water level in the filter and that in the clear water reservoir, varies from 8 to 16 ft., depending upon the porosity of the sand bed. A clean filter requires less head, while a filter partially clogged with impurities requires a greater head. In practice, regulating devices are provided which vary the working head so as to bring about a uniform rate of flow through the sand bed, regardless of its condition of porosity.

When the sand bed has become clogged to the desirable limit with the impurities removed from the water, the operation of the filter is stopped. By means of suitable valves water under pressure from the city mains or other source is then admitted to the collecting pipes beneath the sand, whence it is forced through the numerous strainers and upward through the sand bed, engaging and carrying with it the accumulated impurities and passing off through a suitable pipe at the top of the filter to the sewer. Frequently an agitating device, most frequently applied to gravity filters, is employed to stir the sand during the process of washing. The most common agitating device consists of arms carried by and revolving in a horizontal plane about a shaft in the center of the filter. These arms carry rake bars which, when the arms are revolved by a suitable engine, gears and shafting, sink into the sand bed and assist in the washing.

Another form of agitating device somewhat used is the compressed air agitator as used in the filter plant at Vincennes. In this means of agitation, air under pressure, from a suitable blower, is admitted to the bottom of the bed through the strainers or through special openings provided and is forced upward through the sand. This is to break up the sand bed before the wash water is applied.

Under certain conditions, some form of agitation in washing is desirable and even necessary, but its necessity under all conditions remains to be proved. An agitating device is commonly used in gravity filters and is seldom found in the pressure type. Any method of agitating the sand filters for city water supplies makes necessary a small engine.

The frequency with which it is necessary to cleanse the filter beds depends upon the character of the water filtered. With Western river waters, receiving preliminary sedimentation, the period between washings varies from 12 to 48 hours; the most common practice under average conditions is to wash them once a day. The amount of wash water required is found to be about 5 per cent. of the water purified, and the length of time to cleanse a filter, from 20 to 30 minutes.

It is often found desirable to begin the wash with unfiltered water, where it can be obtained under sufficient head, finishing with filtered water after the bed has become partially cleaned. After the bed has become thoroughly cleaned; namely, when the wash water entering the sewer runs clear, by the operation of suitable valves, the bed is allowed to filter into the sewer for a few moments until normal conditions are established, when the filter is "cut into" the system and operates as before washing.

The pressure filter differs from the gravity type in that the containing tank, instead of being open, is completely enclosed. Gravity filters are usually built of wood, whereas pressure filters are always constructed of steel plates riveted together. In the case of a gravity filter, the water is elevated to the top of the filter by pumping, and thence flows by gravity through the filter to the clear well. In the case of a pressure filter, the water is lifted from its source or from settling basins by the main pumping engines and is discharged through the filters into the city mains, the filter shell or enclosing tank, being under the pressure of the city mains.

In a gravity plant, the loss of head is a fixed thing, being always the difference in level between the filter tops and the surface of the clear water reservoir. In a pressure plant, the lost head in the filter varies from 3 or 4 ft. with a clean filter to 12 or 16 ft. with a filter in need of washing. This saving of head slightly cheapens the cost of pumping.

With waters where preliminary sedimentation is not required, or even where it is required for a portion of the year only, the pressure filter makes possible a considerable economy, in that only one pumping is required; whereas in a gravity filter plant, the water must be handled by two separate sets of pumps at all times.

In water works practice, the filter plant usually consists of three or more filters so that the operation of filtering need not be completely stopped when one filter is cut out for washing, the filters being washed one at a time.

As a result of treatment by sedimentation and filtration, even the most turbid of natural river waters can be rendered clear, bright, and free from all suspended matters visible to the naked eye. Filtration is also efficacious in removing the color or stain found in some waters, especially waters of the north discolored from the bark of floating logs, or other vegetable matters.

The measure of a filter's ability is usually based upon its power to remove bacteria from the water filtered. It being a well established fact that the bacteria or germs of certain contagious diseases, such as cholera, yellow fever, and typhoid are often transmitted through the agency of the domestic water supply. It is not claimed that filtration as practiced, will remove all the germs or bacteria from water. Tests have demonstrated repeatedly that a purification of over 99 per cent., as measured by the removal of bacteria, can be obtained under certain conditions. The highest percentage of purification is obtained when the water to be purified contains a large quantity of germ life.

With waters low in germ life, that is, containing a small number of germs per cubic centimeter, the percentage of the germs removed is naturally smaller; and yet the filtrate in the latter case may be equal, in all respects, to that in the former.

A reasonable clause in the guarantee of filter companies, in this respect, would be to the effect that at all times when the bacteria in the filtered water exceed 2,000 per cubic centimeter, the filter shall effect a removal of 97 per cent., and that when the unfiltered water contains less than this number the filtrate shall contain not more than 200 bacteria per cubic centimeter.

That the purification of a polluted public supply has a great effect upon the general health of the community there is no doubt. The value of the process of "slow sand filtration" has been known for many years, but no longer ago than six or eight years it was common to read in water works text books, that mechanical filtration is a clarifying process and has little effect in removing disease or other germs from water. The public has been greatly enlightened in this matter, and mechanical filtration placed upon a sound basis, largely due to the tests of water purifying devices by a number of large cities, within the past five years. Notably among these are the tests at Providence, R. I.; Louisville, Ky.; Cincinnati, O.; Pittsburg, Pa.; and Washington, D. C. These have demonstrated that even upon Western rivers where the water is, at times, very turbid, a filtrate can be secured which is at all times clear and bright and which contains no more bacteria per unit of volume than many of the ground waters which are regarded as safe and proper supplies.

In regard to the cost of filters and their appurtenances, varying conditions make it impossible to make a definite statement. The range in prices in different localities render any statement very general in character. However, in a general way it may be said that a "mechanical filter plant" of 1,000,000 gallons capacity per 24 hours, with immediately adjacent pipes and valves will cost, to-day, from $6,000 to $9,000. To this must be added from $3,000 to $5,000 for the enclosing building and foundations. To this again, in most cases, must be added the cost of reservoirs for settling and for storing the clear water.

Providing the filter plant is of ample capacity to meet all calls from the pumps, a clear-water basin costing not to exceed $1,500 will meet the needs of a 1,000,000-gallon gravity filter plant. With a pressure filter plant, a clear-water basin is not used.

Settling basins of wood which are applicable to water works can be constructed for approximately $10 per 1,000 gallons of contained volume. Thus, in a purification plant of 1,000,000 gallons capacity, in which it is desirable to settle the water for a period of four hours, the cost for settling basins of wood would be about $1,700. Circular masonry reservoirs packed with earth, under favorable conditions of soil and topography, will cost 20 per cent. more, while steel tanks under present prices will cost 50 per cent. more. Earth reservoirs lined with concrete will be found advantageous in some cases. Rectangular masonry reservoirs have their advantages, but their first cost is much higher than that of wooden tanks.

From the above figures a typical mechanical filter plant of 1,000,000 gallons capacity per twenty-four hours would cost approximately:

Filters and pipes	$ 7,000
Settling basins, wooden tanks, 4 hrs. capacity	1,700
Clear-water reservoir	1,500
Building	4,000
Low service pump, sewer, etc.	1,000
Total	$15,200

In water works not exceeding 1,000,000 gallons maximum daily pumpage, and where the machinery is not unusually complicated, the operation of a filter plant, if immediately adjacent to the water works, requires the addition of no permanent employee to the water works force. In such plants, the cost of filtration includes only the cost of coagulant, wash water, cost of double pumping and some slight temporary labor upon infrequent occasions, incident to repairs, etc. In such a plant as the above, pumping on the average 750,000 gallons per day, the water being of such quality as to require an annual average of one grain of alum per gallon of water, the extra operating charge against the filter plant would be approximately as follows:

39,000 lbs. of alum at $1.75 per cwt.	$682.00
Coal in pumping wash water	7.00
Extra labor	50.00
Cost of coal incident to double pumping	100.00
	$839.00

Cost per million gals. pumped	$ 3.08
Cost per thousand gals. pumped	3 mills

Slow sand filter beds are more expensive in first cost per million gallons of water pumped than mechanical filters, and with turbid waters such as flow in our Western rivers, are more expensive to operate. Mechanical filters have an added advantage in that they occupy a smaller space and their form and arrangement enables a mechanical filter plant to be added to indefinitely; a large plant differing from a small one, usually, only in the number of filters. This is true in a measure of "slow sand filtration," but suitable areas of land at the proper elevation are usually limited in extent.

The first cost of slow sand filters is quite variable, depending largely upon the adaptability of the land to this form of construction. The "slow sand filter plant" at Grand Forks, No. Dak., has a capacity of 1,500,000 gallons in 24 hours and is reported to have cost, with settling basin, $42,500, or $28,000 per million gallons of capacity. The annual cost of operating the beds is said to be $4,500. The Albany, N. Y., "slow sand filter" plant, including settling basins, recently constructed, cost approximately $500,000. The rated capacity of the beds is about 15,000,000 gallons per 24 hours and the total cost of the plant per million gallons capacity was about $33,000.

While good results are obtained from filtration, and while water can often be filtered and supplied to a city at less cost than water from deep wells, a well supply free from all possible source of pollution, if otherwise suited to domestic uses, is to be preferred. However, there are many cities throughout the country where a suitable well supply is impracticable or impossible; to such cities, filtration comes as a great boon.

REPORT OF THE COMMITTEE ON WATER WORKS.

To the Members of the Illinois Society of Engineers and Surveyors:

GENTLEMEN: Undoubtedly new water supply construction in the State of Illinois is at a low ebb, owing to the continuance of unfavorable legislation. But few new works have been built of recent years, and it is increasingly difficult to finance new propositions, as bankers and bond buyers will not consider securities of this class in this State under the present circumstances. Many small cities of the State would be exceedingly glad to install supplies and pay for them liberally if it were possible to do so in any legal manner. As a consequence of these unfavorable conditions, water supply engineering in this State is confined to the remodeling and extension of works already built and the improvement in the purity of present sources of supply by means of filtration. Large improvements of this kind are being constructed at Moline and Danville, under the direction of one of our members, and many smaller places are considering the matter.

In water purification, much thought and study is now being given to the preliminary processes which must be adopted to remove sediment and turbidity and prepare the water so that it may be properly passed through the filters without undue clogging or washing. Sedimentation has long been the favorite method of accomplishing this result, but other processes are coming to the front for the same purpose. The city of Philadelphia, after two years of careful experimental work, has reached the conclusion that turbidity may be removed and the ordinary rates of flow through slow sand filters may be doubled by the use of so-called preliminary filters. The city has let a contract for an installation costing $90,000 at the lower Roxborough station. These preliminary filters will consist of 11 tanks 16x64 feet in area, and 5 feet deep, each containing a coarse material averaging $\frac{3}{8}$ inch diameter, superimposed upon a layer of broken stone in which is laid the entrance pipe corresponding to the under drains of an ordinary filter. The filter is operated with the inflow from below and the turbid waters are deprived of their suspended matter by mechanical adhesion to the particles of the filtering medium. In order that the upward flow may be uniform, a mattress of sponge 8 inches thick is held compressed uniformly over the top surface of the filter, and through this the flow must finally pass.

The experimental tanks have shown that with raw Schuylkill water 70 per cent. of the turbidity and 90 per cent. of the bacteria have been removed, with a cost of wash water of 40 cents per million gallons, and a labor cost of 30 cents per million gallons. The slag of which the body of the filter is composed has to be washed once a day by reversal of flow, the outlets for this purpose being made seven times the area of the inlets. The sponge mattress requires removal and washing four times a year, and it will be noted that the Schuylkill River water has a maximum turbidity higher than that of the Ohio River, although its average is not equal to the latter stream.

Such preliminary filters are operated at rates of 60,000,000 to 80,000,000 gallons per acre per day without chemicals of any description. A head of approximately 1 inch to 12 inches is used in passing the flow through the filters. Mr. John W. Hill, to whose kindness I am indebted for this information, assures me that in Philadelphia they expect to largely increase the rate of flow through the final filters as a result of this preliminary work.

The larger portion of the water supplies of this State are derived from artesian sources and it has become increasingly difficult for many of the larger cities in the northern part of the State to obtain a sufficeint quantity of this valued water for domestic purposes. Many ingenious plans have been devised for increasing the flow of such wells, such as the Rockford plant constructed by one of our fellow members.

Recently the writer has been engaged in designing a new form of rotary pumps for a large railway company near Chicago, in order that it may develop a supply of 5,000,000 gallons daily from artesian wells. The lift will be nearly 200 feet, and it is proposed to lower the pumps directly into the artesian wells and drive them by means of shafts directly connected to horizontal electric motors at the surface. A trial installation has been constructed at the company's works and preliminary tests give assurance that the obvious difficulties can be overcome and good efficiencies obtained. Development along this line promises a good field of activity.

In conclusion, your Committee would note the widening field in rotative machinery for pumping purposes generally. The high efficiencies which have been recently obtained for centrifugal pumps compounded and in tandem, are worthy of mention, while positive displacement pumps of rotative type are already successfully launched on the market.

A large amount of engineering work is to be done in the future in establishing the purity of water supplies. An enthusiastic sanitary engineer recently remarked to the writer that the time was near at hand when public opinion would require that all surface supplies must be filtered. That this is no idle prediction, is being realized by sanitary engineers everywhere, and much earnest and careful study is being given to the elimination of water borne pollution as a menace to the public health.

JOHN W. ALVORD, Chairman.

DISCUSSION.

PRESIDENT: It may save some of you trouble if I call your attention to some of our experiments in this line. Some years ago, the Legislature passed a law that was intended to give cities power to build water works systems, and it gave power to issue bonds for water works purposes. But when we tried to apply it in Moline, the banks that were asked to buy the bonds refused, thinking it was probably a violation of the constitutional bonding limit, which limits the bonded indebtedness for all purposes to 5 per cent. of the assessed valuation of the property. As a matter of fact, we all know that 5 per cent. bonded indebtedness of assessed valuation does not mean very much. Nearly every city is up to or very nearly up to that limit all the time for ordinary improvements, and when it comes to the question of water works construction, the amount is so much that it goes away beyond.

Consequently, although the Legislature was in good faith and intended to give us a remedy, it failed to do so. The trouble is that not enough cities own their water works; those owning them are the exception and not the rule, and they have allowed that provision to get into the constitution. The ownership of the water works by the city is a business transaction. Any private corporation that owns water works in a city would always do anything towards the improvement of that plant that would be sure to bring them in a sufficient return, whereas a city is handicapped by the 5 per cent. limit. I am inclined to think that the only remedy is in some amendment to the constitution which would except that kind of indebtedness.

MR. JOHN C. QUADE: While on this subject, it would be a good plan if the President would give us Mr. Mead's plan for water works at Moline.

PRESIDENT: I have no data at all with me. We have not finished anything, and I would rather not attempt a description at this time, as I am looking forward to the time when I can invite the society to Moline and give them, not a theoretical, but a practical illustration. I will say that we have adopted the principle that we can only spend at any time what we can see in sight. Now, the administration of Moline has been working to this end for the past two years, in fact three years, and is saving a certain amount each year, all that it is possible to save in this way. Bonds that were redeemed under the sinking fund provision, were not reissued, but were allowed to accumulate until something like $60,000 of such bonds have matured and will mature this year. Then the revenue that can be devoted to this purpose next year is $20,000, which will make $80,000, and possibly will produce $20,000 more. To cover the uncertainty of that $20,000, as the city cannot go into any contract legally unless the money is in sight to do it, and not being able to make it perfectly sure, about a dozen of the leading manufacturers of Moline were asked to make a proposition to the city that they would, if necessary, advance this $20,000 and receive the money back in water at a certain fixed reasonable price. This they did, and the proposition was duly accepted by the City Council. This provided for the $20,000 in case the revenues are not sufficient.

The year before last we put in about 9,000 ft. of 12-in. mains to go up on the bluff districts and reinforce old mains that had ceased to be effective, to give them service up there, and they will answer the purpose for some time.

It might be interesting to say that we have been in such a condition that we have not been able to put up money for even small extensions of mains in new territory. The city owning the water works, it did not look quite fair, having put in and paid for water mains of all kind in the city, to change the system by putting in water mains by special assessment and have property owners pay for them and then go on and pay for the water they used. So this plan was adopted. The Council passed an ordinance providing that in the future every property owner should have a rebate on his water rent, equal in amount to any sum he might have paid on special assessment on water mains. Whatever his bill amounted to he got his money back in rebate until he had received the whole amount. Then under these conditions we lay the mains by special assessment. It was the only way we could lay a sufficient amount of water mains. We have let our contracts for the necessary work and I hope we shall get it done in good time, then I shall be glad to show it to you.

MR. T. W. SNOW: While on this subject, we might touch a little on whether the distribution of water should come under the general construction of water works plant or whether it should be by special assessment. We have already touched a little upon that.

PRESIDENT: This will come up in connection with a discussion which is on our program: "Present improvement laws of the State of Illinois."

PRESENT IMPROVEMENT LAWS OF THE STATE OF ILLINOIS.

DISCUSSION.

NOTE.—Some matter relative to this subject was brought out in the foregoing discussion on the report of the Committee on Water Works.—SECRETARY.

A MEMBER: I would like to say in regard to the present Public Improvement Law in this State, that the law has resulted in a great deal of inconvenience to some of our prosperous small towns. The larger towns have provided several ingenious ways of escaping the effect of our statute, particularly some around Chicago. Where the 5 per cent. of the assessed valuation means 1 per cent. less than the real valuation, they simply cannot put in water works, but by adding special assessments they can put in water works.

MR. J. M. MCNABB: I think that either the appellate court, or perhaps the supreme court, has just passed on this law.

PRESIDENT: The gentleman is entirely right as to the inconvenience. Under the present improvement laws of the State of Illinois, you have to resort to three different methods to accomplish one result, and this in itself indicates that there is something wrong with the law. That complication adds very materially to the cost of the municipality, and the people in the end have to pay a large additional percentage.

MR. J. W. ALVORD: It has been about ten years, I think, that engineers have been trying to overcome the restrictions imposed by the decisions of the supreme court. You all remember there was a time when we could operate under the short-term franchise idea; when the contractor took short franchises, say for six months or so, and turned the completed plant over to the city to be paid for out of the revenue. That worked well for a time and there were a good many works built under that plan, but finally the supreme court wound up that method of doing business. Later there was a time when we could include stand pipe and reservoir in special assessments, and that left the pumping station only to be paid for from the general fund, but the supreme court took that right away from us, and now under the new law it is simply impossible to do much of anything. No general plan can be made with the expectation that it can be carried out as it is intended, because of the uncertainty of the petition. This, of course, has been a set back, not alone to municipal projects, but to the water works owned by private corporations. These latter have suffered perhaps more than the municipal plants have, by reason of the decision by which the City Council may reduce the water rates until only a "fair return" is given, as was decided in the Rogers Park and Danville cases.

You cannot go to bond buyers or banks anywhere now and say that you have a water works proposition and want to sell the bonds. They will ask you, "What State is it in?" and when you reply that it is in Illinois, they will tell you they cannot consider it. They want to be sure they will have their money back; and unless they are sure of getting it back they prefer something else in the shape of an investment.

One of the recent cases that has come up in Iowa has resulted in a decision of the State Supreme Court, in which it has been held that a city can bond itself for a water works plant without that bond issue being considered as part of the general indebtedness of the city, but the case was also carried up in another form in the circuit court of the United States and passed on at St. Louis, and a decision was handed down contrary to the decision of the State court. Of course the case will get into the supreme court.

I think things cannot go on much longer in this way. Many propositions come in to engineering offices from smaller places which want water works plants and want to be told how to finance them. Nothing can be done for them under the present decision of the courts.

PRESIDENT: In my address which was read yesterday, when only a few were here, I touched on that question, and was very brief. I only took up the sewer question, not meaning to say there were not others, and instead of theorizing I simply followed our experience in one case, although I gave it generally, but it is an exact history of a case we had in our city. We are a little differently situated at Moline, perhaps, than most cities. Our main sewer is a storm waterway and sewer combined, and a very large one, 8 ft. diameter. We have several sub-districts, perhaps more than most towns. We have these sub-mains to a great extent already in and fortunately, we have succeeded in keeping them about where they belonged. We have these mains and they are in practically; some of them the city put in out of the general fund.

In order to present some of the troubles I wrote the following:

> The discussion of the present improvement laws should be very interesting to many of us, as all classes of cities have discovered serious defects in the law as it applies to them. In the class of cities under 25,000 inhabitants, the law seems to be satisfactory as regards paving, and other improvements of the surface of the streets, but it has been found practically impossible to secure the signature of the owners of one-half the frontage along the lines of a proper sewer district, for the reason that some portion of the main sewer is almost always very expensive and the property owners along the expensive portions of the main object to signing a petition for a sewer that will not include the lateral and cheaper portions, and the property owners along the laterals and cheaper portions wait, hoping that the property owners of the

more expensive portions will do that work and leave the laterals to be done later without having to share in the cost of the most expensive portions.

Our city (Moline) is valley, hill-side and upper flat. In a sewer of 500 or 800 feet in length we have very deep cutting. In one instance 800 feet averaged 22 feet cutting. That made an outlet for the general system of perhaps an area of a quarter section half a mile wide. The cost would not have been oppressive if all the territory had been assessed that was tributary to that outlet, but under this law we could not do it, and until the cities are interested, that is until cities of our size take sufficient interest to use their influence with the Legislature, we will have that condition. If the exception could be made for water works and sewers, then the Council could pass the necessary order, and territory sufficiently large could be taken in that would not be oppressive.

MR. McCLANAHAN: I suppose you are all aware that "Necessity is the mother of invention." I conferred with the Trustees in Henry County in regard to water works for a village there. There was not enough water in any well in town to fight a fire. The Council agreed to pass upon an estimation. In the ordinance made out for water certificates, it amounted to $15,000. The inhabitants of the town were only 800, and they could only raise at 5 per cent., $5,000. I had received word that this matter had come up before the courts and it was decided that they were not good property and I so stated to the Trustees. But they were obliged to have water. They then gave notice that there would be an election. Nearly the entire number of voters turned out and only 17 of the city voted against it. They passed the ordinance to put in water works. I put in the water works system so that it covers the entire town. There is not a block in it that cannot be reached with a hose 500 ft. in length. Their plans and ordinance were examined by a competent lawyer in Chicago. They sold the bonds and got the money, the plant is in and paid for, every dollar of it. The plant was finished five weeks ago. The bonds were issued in Woodhull.

MR. H. D. HALLETT: There was a law passed in 1899 giving towns and cities the privilege of bonding their towns for water works purposes, provided they had a vote of three-fourths majority. Nothing has as yet been done under this law as no bond house would take the bonds.

PROF. A. N. TALBOT: In discussing what changes should be made in the improvement laws of Illinois, and how the cost of public improvements should be divided between general taxation and assessment, I assume that we will all agree that in sewers, pavements and water works, it is proper to divide the cost, and that the question of how much should be paid by general taxation and how much by the assessment will depend quite largely upon local conditions. Formerly all improvements were paid for out of the general fund, and the property owner was expected to pay according to the amount of property he possessed. I think, however, that since special assessments have been general this has been found a desirable method of apportioning cost. A piece of vacant property which would have a very low assessed valuation, may be benefited by any improvement just as much as or more than the improved piece of property next to it. In making the distribution of cost, then the peculiar conditions connected with the work must affect our distribution. Take for instance water mains, which is perhaps more nearly a general improvement than anything we can suggest. It seems to me that a considerable part of the cost of the water mains should be borne by the property owners on some basis of benefit, rather than on the basis of valuation, enough at any rate to pay for the cost of the ordinary size of water mains, say a 6-in. main.

Take pavements. It was formerly thought that because the improvement was used by the public, therefore the public should pay for it. It is true the public uses it, but the paving improves the property, making it more desirable. Even if a man who owns a piece of property does not have a horse, or use a wagon, he does employ merchants and delivery men in bringing goods to his house. In appearance, in permanency and quality of surroundings, and in other ways, the property is materially benefited. In general, benefits are sufficient to warrant a considerable tax by special assessment, and the portion properly collected by this method must depend upon the local conditions.

However, whatever we may think is the ideal system we are hampered in this State by our constitution and laws. The limitations make it very difficult at present to put in public works of importance in this State. There must be a great demand for the improvement and the town or city must be in a progressive condition to undertake it. I think we can all agree that something ought to be done, and that Illinois is too progressive a State to allow the present law to continue without modification. The passage of a general law which would provide for raising an adequate sinking fund would be helpful. If it was easy for cities to raise an extra tax for the payment of their bonds, they would be in shape to do something at some future time.

NOTES ON THE ABSORPTION TEST FOR PAVING BRICK.

BY PROF. A. N. TALBOT.

Engineers generally appreciate the desirability of uniformity for brick which is to be used for street paving. A lack of uniformity will produce conditions making new pavement necessary long before the brick have been worn out. It has been conceded that the absorption test has many advantages in convenience for determining the uniformity of brick. The principal objection to this test has been the wide difference in the amount of absorption in the best grades of brick of different clays and different methods of manufacture. This wide divergence has made it impracticable to give a general limit for the absorption test. The Committee on Paving Brick Tests of the Illinois Society of Engineers and Surveyors in 1901 reported a suggestion of a range of porosity above and below the amount given by the brick submitted as samples, and favored an investigation of the feasibility of this plan. The form of this suggestion was as follows, the figures submitted being merely tentative:

> At the time of submitting bids, the bidder shall furnish 25 bricks of the make specified in his bid, on which a rattler test and an absorption test shall be made. A requirement for brick furnished for the pavement will be that their absorption tests shall fall within the following limits: When the result of the absorption test of the sample bricks is below 2 per cent., the limits shall be ¾ per cent. less and 1 per cent. more than the sample; when between 2 per cent. and 5 per cent., the limits shall be 1 per cent. less and 1½ per cent. more than the sample.

The data now on hand indicate that while it may be feasible to establish such a rate for the upper limit of absorption for a given grade of brick, for the lower limit the requirement would be ineffective, at least so far as some makes of brick are concerned. It is found that the difference in amount of absorption in over-burned brick and in properly burned brick is so slight that no conclusion may be drawn. In other words, after the proper point of vitrification is reached, further burning does not materially decrease the porosity, and over-burned or cindery brick may absorb practically as much water as the best brick.

Mr. James Barr, of the class of 1902 of the University of Illinois, for his thesis work made investigations for a comparison of paving brick tests. Among the many tests made was a comparison of the abrasion test and absorption test of brick. By using the Talbot-Jones rattler, Fig. 1, in which the brick are clamped around the periphery of the machine (thus forming the wearing drum), he was enabled to get the tests of individual brick and thus get a more definite relation than that given by mere averages.

Four makes of brick were used and from two to three grades of each make—medium burned, soft burned and over-burned. The method of selection was by the eye. While this was not entirely satisfactory, and the external appearance did not always agree with the internal structure, yet the grades of brick were taken so far apart that in each case the general average of the brick in each grade was quite distinct from that of another grade. The diagrams given will indicate the amount of the variation.

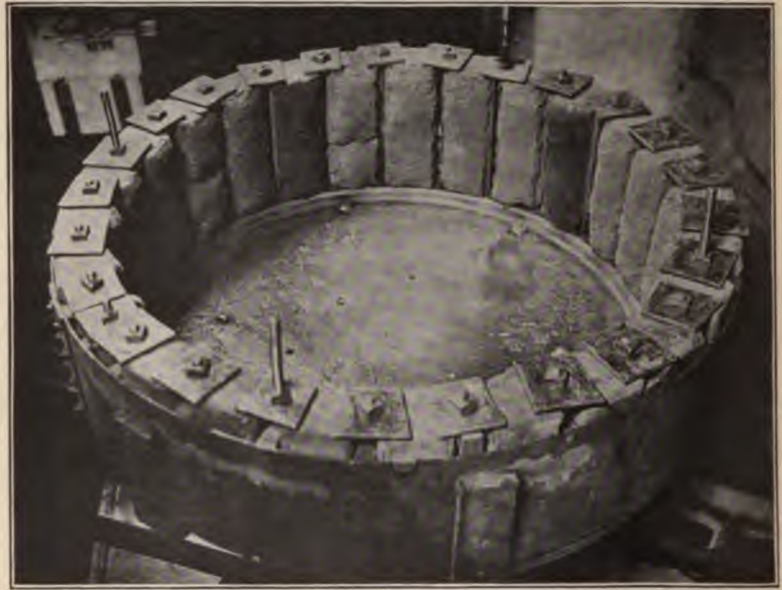
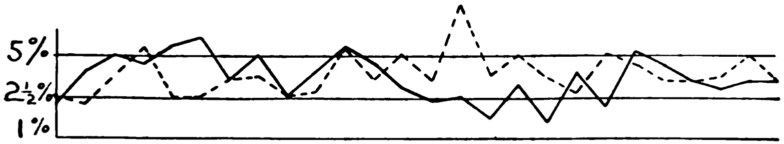


FIG. 1. TALBOT-JONES RATTLER FOR TESTING PAVING BRICK

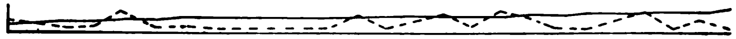
In the test with the Talbot-Jones rattler, the space was such as to take one less brick than the number which would just fill the rattler. The rattler was given 3,000 revolutions at 41 revolutions per minute. The charge consisted of 60 pounds of cast iron cubes weighing 3½ pounds and 90 pounds of cast iron cubes weighing 0.9-pound each. It should be noted in passing that it was found that this charge and method of rotation gave too large an impact effect, more chipping resulting than is proper for this class of brick; but after all, even with these imperfections, the effect of the test showed a wear and gave results much more nearly in accord with the actual wear in the street than does the standard rattler test of the National Brick Makers' Association.

Fig. 2 shows the relative wear on the two sides of the same brick. The averages agree very closely. The variations due partly to accidental conditions of the test, such as one brick projecting a little above the next, or a hard brick being next to a soft one, but

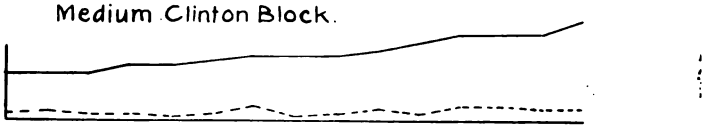


The points represent the wear of two faces of the same block.

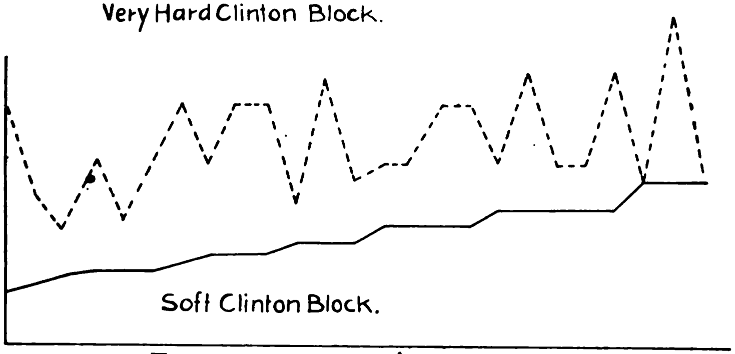
FIG. 2. TALBOT-JONES RATTLER TESTS OF MEDIUM CLINTON BLOCK.



Medium Clinton Block.

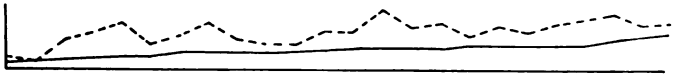


Very Hard Clinton Block.

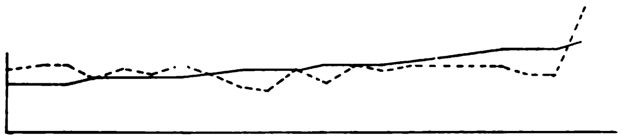


Soft Clinton Block.

FIG. 3. TALBOT-JONES RATTLER ABRASION TESTS. 1% ——
ABSORPTION TESTS. 1% - - - - - - - - - - - - -



Medium Hard Veedersburg Brick.



Soft Veedersburg Brick.

FIG. 4. TALBOT-JONES RATTLER ABRASION TESTS. 1% ——
ABSORPTION TESTS. 1% - - - - - - - - - - - - -

principally to the fact that bricks may have imperfections on one edge which are not found on the other.

Fig. 3 gives a comparison of the results of the rattler test and the absorption test for medium, over-burned and soft grades of Clinton block. Fig. 4 gives a comparison of the rattler and absorption tests for medium and soft Veedersburg block.

An inspection of the plates will show that the brick selected are fairly uniform if the amount of wear is to be used as the criterion, while there is much more variation even for the best brick if we consider the absorption test.

In general, however, the absorption test for the soft brick shows much higher results and gives greater loss in the rattler than the medium burned brick, so much so that it may be said to be indicative of the quality of the brick. On the other hand, the absorption test for the hard-burned brick averages almost exactly the same as that for the medium or best brick. For example, the average for the medium Clinton block is 1.2 per cent., while that for the over-burned block is 1.0 per cent.

It may be stated that the loss by the Talbot-Jones method for the soft, medium and hard Clinton averages 8.44, 4.02 and 15.90 per cent. The soft brick thus loses nearly twice as much as the medium, and the over-burned nearly four times as much as the medium brick. Similar ratios were found for Terre Haute, Veedersburg and Danville brick. This marked difference in the losses in the different grades of brick is quite a contrast to the slight variations found in testing the same grades of brick by the standard rattler method, the loss in such cases for the poorer brick being only from 10 to 20 per cent. more than the loss for the best brick.

In conclusion the following statements may be made:

1. For the grades of brick tested the absorption test reliably determines the softer and less burned grades of brick, and is useful when the average porosity for the well-burned brick is known.

2. The absorption tests have no value in determining over-burned brick, no change in porosity evidently taking place after the point of proper vitrification has been reached.

It must be borne in mind, as has been understood for some time, that brick with a coarse fibre will have a different absorption rate from a fine grained brick, and that the process of annealing has so great an influence that it may modify the effect of porosity.

It may be stated in further explanation of the statement that the Talbot-Jones test as used gave too great an impact effect, that experiments are now in progress to determine a charge of shot and a speed which it is hoped will make this test more reliable and discriminating than any test now in use.

RELATIVE STRENGTH AND COST OF NATURAL AND PORTLAND CEMENT CONCRETE FOR STREET PAVEMENT FOUNDATIONS.

DISCUSSION.

PROF. A. N. TALBOT: I suggested this topic, and have here a little information relating to it. It is known that pavements settle over old excavations much more than we should really expect them to. In the pavements in Champaign, depressions have occurred where sewers were put in several years in advance of the pavement. On a pavement made with Portland cement concrete, using a coarse sand (locally called gravel) and no broken stone (1 part Portland cement to 7 parts gravel), no depressions are found. But over similar trenches next to it, on the natural cement concrete, the pavement shows bad holes. Excavation through this Portland cement concrete showed a concrete of superior strength, and it was decided to make tests to find the relative cost and strength of different mixtures of pavement concrete. The work was done by Mr. Gearhart, who has been for some years pavement inspector for Champaign. The costs have been worked out by him, and the results are interesting and instructive. In arriving at the costs, gravel and sand were taken at 90 cents per cubic yard; broken stone, $1.40 per cubic yard; Utica cement, 55 cents, and Portland cement, $2.65 per barrel.

CONCRETE.

Proportions			Crushing Strength 30 days Lbs. per square inch			Modulus of Rupture Lbs. per sq. in.	Beam 6x6 inches 18 in. span Loaded in Middle Lbs.	Cost per sq. yd. Cents
Cement	Gravel	Broken Stone	8-inch cube	6-inch cube	Average			
Utica								
1	3	3	610	542	576	160	1280	34
Atlas Port.								
1	4	4	1328	1364	1346	305*	2440	59
1	5	5	2104	1546	1825	350	2800	48½
1	6	6	894	1287	1090	320	2550	47
1	7	7	1241	1283	1262	282	2100	42
1	5	..	1693	1564	1628	336	2700	64½
1	6	4	1181	1171	1176	225	1800	48

*Defective.

PAVING BRICK CEMENT FILLER.

Atlas Portland Cement	Sand	Brick	Modulus of Rupture Lbs. per sq. in.	Beam 6x4 in. 18 in. span Loaded in Middle	Cost of Filler per sq. yd. Cents
1	1	Clinton Block....	351	1248	8 to 12
1	1	Clinton Block....	452	2416	......

Cement filler,
Clinton paving brick,
Portland cement.
Proportions: 1 cement, 1 sand.
Modulus of Rupture:

4x10½ inch brick beam 24 inches between supports; load in middle, 1640 lbs.

$$R = \frac{3}{2} \frac{w\,l}{b\,d^2} = 351 \text{ lbs. per sq. in.}$$

With R taken at 351 lbs. per sq. in., a brick beam 6x4 inches, 18 inches between supports, loaded in the middle, will carry 1248 lbs.

A brick beam 4x10¾ inches, 24 inches between supports, load in middle, 2160 lbs.

$$R = \frac{3}{2} \frac{w\,l}{b\,d^2} = 452 \text{ lbs. per sq in.}$$

With R taken at 452 lbs. per sq. in., a brick beam 6x4 inches, 18 inches between supports, loaded in the middle, will support 2416 lbs.

THE APPLICABILITY OF THE SEPTIC TANK TO SEWAGE FROM COMBINED SYSTEMS OF SEWERAGE.

DISCUSSION.

PROF. A. N. TALBOT: This topic is the result of an inquiry which has been made concerning the use of the septic tank with the combined system of sewerage. As is well known, most of the septic tanks in operation in this country are taking care of sewage from sanitary sewers only, and the question is whether they can as well take care of sewage from combined sewers.

There is comparatively little grit which comes from the house sewage. The sewage from sanitary sewers is also less broken up than the sewage from combined sewers. These conditions of course are favorable to the use of the septic tank for sanitary sewers. It should be expected that there would be obstacles to overcome and additional arrangements to be made for the septic tank on a combined system. However, the septic tank is in successful operation in a number of places where sewage from combined sewers is treated. I think the largest use is in Manchester, England. In this particular case there is a large brick chamber for taking the grit from the sewage. Leeds is another English city which has the septic tank in use with combined sewers. In this country there are several cities using the combined system and the septic tank. Fond du Lac, Wis., has one and I am told that the septic tank there is successful.

It would seem that the principal precaution to be taken would be the provision of grit chambers for taking the ordinary grit from the water and to provide for discharging the storm water through an overflow. These two obstacles are matters which may be readily remedied if proper care is taken in designing the system.

One word more may be said. I think in a general way we may not expect as good a purification with combined sewers as we should get with sewage from sanitary sewers.

MR. J. W. ALVORD: On the question of allowing storm water to enter septic tanks, it may interest the Society to know something of my experience in operating the Lake Forest plant this season. The Lake Forest plant was designed to take the sewage from a separate system and was built for a capacity of 250,000 gallons per day. It appears, however, that the city of Lake Forest had been in the habit for some years past of connecting their catch basins and roofs with the sewers wherever flooding of the streets was not likely to occur. This resulted in a large amount of storm water being delivered at the plant after each rainfall, the amount being something like 2,000,000 gallons per day for as much as 20 to 30 hours.

The City Council was notified that the catch basins should be removed, as they were in every case a violation of the city ordinances, but after several ineffectual attempts it was found impossible to discover and remove all of these connections and the matter was finally compromised by building a by-pass around the plant so that all the overflow above the maximum capacity of the plant was emptied directly into the lake. This overflow was constructed to deliver as much storm water as possible through the plant before passing any direct to the lake, and thus the plant received all the storm water that it could care for. This was at first believed to be detrimental, but close observation seemed to show that no serious harm was done. Indeed for a week after a heavy rainfall, the plant, and especially the septic tank, appeared to be in better condition than ever. Very little suspended matter at such times was carried over on to the beds. The first rush of storm, however, was apt to carry over more suspended matter than was desirable for a few minutes.

I think that this illustrates what I have often noticed before, that the more dilution that can be provided for sewage the better, providing the flow is reasonably uniform. All diluted sewage seems to be more easily handled than concentrated sewage, and even a temporary amount of dilution, covering only a period of from 20 to 30 hours, is in many respects better than the necessity of constantly treating a concentrated sewage. It should be remembered in this case, however, that after the first rush entered the tank, the flow of storm water was quite uniform during all the period in which it was passing through the tank. This would not be the case were storm water permitted to enter tanks in the usual manner.

I cannot help feeling therefore that a limited amount of storm water, such as is often permitted to enter septic tanks in ordinary English practice, does not seriously injure their action, after the first few moments of the rush.

MR. B. J. ASHLEY: Concerning the admission of storm waters into the small septic tank which I had in operation at my residence for over twelve years, my experience was that the storm water gave it an occasional cleansing, and prevented the "mat" from becoming hard. The septic action of the common residential waste that daily entered the tank was not in the least disturbed, as far as I could discover. This storm water came into the tank through the overflow of the cistern. During my experience as chief engineer at Zion City, Ill., I built several tanks of a capacity ranging from 160 gallons to 5,000 gallons in which no storm waters were admitted and I did not discover any better action in these tanks than I did in my private one.

MR. T. S. MCCLANAHAN: I am at the present time putting in at Monmouth a plant large enough to accommodate 350,000 gallons.

The tank I am putting in is 105x70 ft., with two compartments, each 35x105 ft. Our system is entirely combined. Our sewers are in the middle of the street. We take all of the storm water, downpour from houses and rainfall from the heavens. We have leading to this tank one sewer 49 inches in diameter, and another coming into the same. Storm water separating box is 36 inches. Our city is drained by two separate lines of sewers. We have in all about 27 miles.

EXCLUSION OF FACTORY WASTES FROM SEWERS.

DISCUSSION.

MR. T. S. MCCLANAHAN: If this is the proper time for it, I have a problem I would like to present here, in regard to a matter which we are deeply interested in, in our city of Monmouth. The question is this, is there any possible means by which we can get rid of the odor and of the material which is corroding our sewers from the coal tar and other oils that pass from the gas works? We have compelled them to put in catch basins that take out all sediment, but we have never been able yet to shut off the oily part. It enters our sewers and corrodes them for the entire length of the sewer. We can follow it for three miles after it enters the stream. We still get the odor and the question I have to propose is this, is there any one here that can suggest any plan or means by which we can get rid of it? It not only enters our sewers, but it is so heavy that it makes its way into houses, notwithstanding they are well trapped. I have noticed its corroding effect on the inside of the sewer as far as it now goes in the sewer. We have not let it into the tank. I feel that the matter itself is non-organic; it has been made so by the heat through which it has passed, but the odor is terrible.

MR. J. C. QUADE: I do not know how to get rid of it, but the most effective way is to make them put in an independent sewer, and make them take care of it themselves.

PRESIDENT: The City Council has the power to keep any matter out of the sewer that would tend to injure it; they should exercise that power if it is injuring the sewer.

PROF. TALBOT: The City Council should put it upon the gas company to take care of their waste product. It is up to them to do it, and they should do it without special urging. Some years ago I made an investigation for the United States government for a method to keep the product of a gas works and oil wells out of the Wabash River. I concluded that it was not a difficult matter to make a separating tank that would readily solve the problem.

SEWAGE PURIFICATION PLANTS FOR SUMMER COTTAGES.

BY JOHN W. ALVORD.

The importance of providing adequate and proper sanitary arrangements for cottages in summer resorts cannot be overestimated when it is considered how rapidly such resorts have grown in the last few years and how closely crowded together cottages are in most cases. The American people are turning their attention to summer homes in large numbers and one of the first inquiries upon which they wish to be assured is that they shall have pure water and proper sanitary arrangements. Failure to provide these two essentials (especially important in country life) is to deprive the summer resort of its greatest benefit to the tired city worker.

Investments in summer resort property are generally made on the basis of the least possible expenditure consistent with comfortable living, and it is too often the case that sanitary arrangements are not perfect, or are left to the neighborhood plumber. If there is no sewer system, and generally there is not, the plumber's idea of sanitation will revert to the old idea of cesspool, which will prove in almost every case to be a nuisance.

It is with the idea that modern improvements in the septic tank and subsequent filtration can be adapted for summer resort cottages where sewer systems are impracticable and the soil of a porous nature that the design shown by the accompanying illustration has been made.*

The flush closet may be situated within the cottage or in a building attached to it as may be desired. It is not a part of the design except to show its general arrangement. The plant proper is arranged so as to utilize materials which may readily come to hand, as far as possible. Three oak casks such as are ordinarily used for vinegar may be purchased at second-hand and when arranged as shown in the drawing will form the septic tank, the anerobic filter, and the flush tank. The inlet to the septic tank should terminate at about the center of the septic tank as shown, and should be ventilated with a 1-inch pipe conveniently located. From the septic tank the sewage will flow through a short connection to the anerobic filter, which should consist of an oak cask buried with its side down. Across the bottom of the cask should be laid a grating of sticks of sufficient strength so that the filtering material may rest upon them, g a free opening below for the circulation of the incoming flow. naterials with which the anerobic filter should be filled should rly coarse at the bottom, growing finer towards the outlet from lter. A graduation from egg to chestnut size would be desir-

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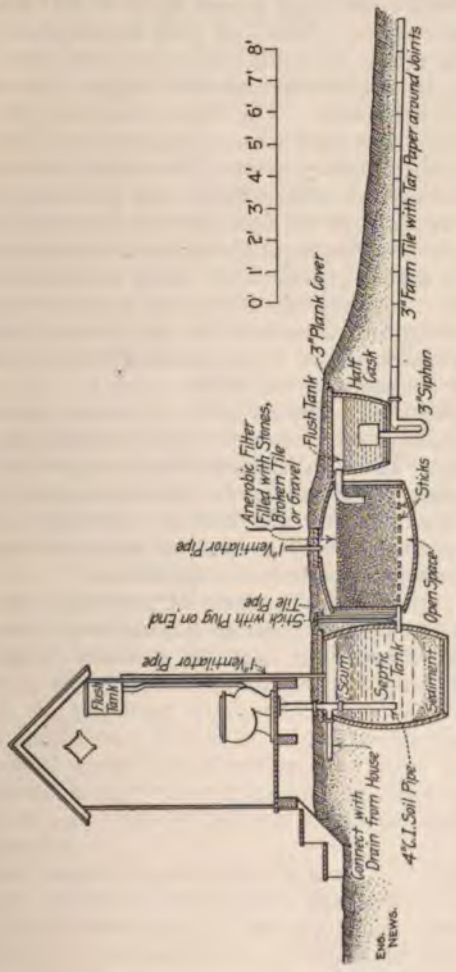
*The cut is from an article describing this system in Engineering News, July 2, 1903.



The outlet from the anerobic filter should be a piece of elbow near the top of the cask, so set that it will control the level of iquid both in the septic tank and the anerobic filter. Provision ld be made between the septic tank and the anerobic filter for ying the larger portion of their contents at the end of the season. device shown on the drawing consists of a tee in which a wooden plug fits, which is removed by being fastened to a stick coming to the surface of the ground. This will drain the casks below the level of the cast iron pipe and prevent any trouble from freezing during the winter.

The flush tank consists of a cask sawn in half and covered with plank as shown. A good 3-inch cast iron siphon should be set in the bottom. This is really the most expensive item connected with the plant and upon its regular action will largely depend the success which the plant will show. The flush tank will fill and empty in proportion as the closet is used and probably will be discharged at least twice a day in ordinary cases. The outlet of the siphon is connected with a line of ordinary farm tile, the grade of which in porous soils should be away from the flush tank at the rate of about 0.2 foot in 100 feet. If laid in fine sand the joints of the farm tile should be surrounded with coarse gravel or tar paper to prevent the sand from entering the tile. In localities where the ground is not sufficiently porous, greater length of tile should be laid, but in fairly porous soils about one foot of tile ought to be laid for every gallon of sewage passing through the plant in 24 hours.

In very stiff and impervious soils a trench should be dug two or three feet below the level of the tile and underdrained to some outlet in the vicinity. The trench should then be filled with coarse sand and gravel, beginning with the gravel at the bottom. The discharging tile should then be carefully laid as heretofore described. The top of the trench may be then covered with soil and no difficulty ought to be experienced with over saturation.

The total expense of the plant here shown, not including the closet or closet bowl, will be about $25, although this will vary in different localities depending upon the porosity of the soil, the cost of the materials, labor and other items.

RELATIVE DISCHARGING CAPACITY OF BRICK AND PIPE SEWERS.

BY ARTHUR N. TALBOT.

The statement is frequently made that pipe sewers of 24 to 30 ins. diameter have a materially larger discharging capacity than brick sewers of the same size. Catalogues of several sewer pipe companies contain statements similar to the following: "All authorities agree that these pipes have a carrying capacity of 50 per cent. over brick sewers of the same size." The writer wishes to raise the question whether there is any foundation for this statement, and whether it is not entirely misleading. It is common usage among engineers to calculate the discharging capacity of brick sewers by Kutter's formula, using for n (the co-efficient of discharge) $n=.015$ and for pipe sewers using $n=.013$. This assumes that the pipe sewer will discharge about 18 per cent. more than the brick sewer. However, it is probable that the real difference is less than this.

The discharging capacity of a conduit is dependent upon its smoothness and upon the uniformity of its cross section. The effect of irregularity of cross section is greater than is ordinarily supposed, and the loss due to an increase in successive cross sections is even greater than that due to the decrease of section.

A brick sewer has many projecting faces, forming roughnesses, but these are small and may become coated with slime. The cross section of a brick sewer is substantially constant. Built by template and on centers, the variation from one cross section is small, except when there is settlement, and with good construction work this is rare. The area of water cross section, therefore, is very uniform, and such a sewer is not subject to loss of head due to repeated change of velocity, and nearly the total fall is utilized in overcoming frictional resistances.

Sewer pipes usually have a smooth surface. There is, however, a rather marked variation in diameter, perhaps as much as ½ in. or even more in pipes from 24 to 36 ins. diameter. In these sizes it is usual to specify that two diameters of the same pipe shall not vary from each other more than 1-24 of the nominal diameter. In laying, the effort is made to have consecutive pipe laid with the inverts continuous. This ordinarily leaves a lack of continuity at the extremities of the horizontal diameter and at the crown of from ¼ in. to 1 in. Even when the areas of adjacent pipes are the same, the form may be different and the water section must be changed as it moves by. With 2,100 to 2,600 changes per mile the cumulative effect of even small differences in diameter is noticeable. Students of hydraulics will recognize the importance of losses due to contraction of section and enlargement of section, particularly when they are repeated every 2 or 3 ft. of the length of the sewer. That this effect is not peculiar to pipe sewers may be seen by a reference to the failure of a large water works steel conduit to carry within 40 per cent. of its expected discharge because account had not been taken of the loss due to rivet heads and to the change of section caused by the plates being placed alternately inside and outside. This failure was a lesson to hydraulic engineers.

Few careful observations on flow in pipe sewers have been made. Experiments by the writer on a well-laid and clean 18-in. pipe sewer on a grade of 1 in 1,000 indicate that a flow larger than that found by Kutter's formula with $n=.015$ cannot be relied on and that with much fungus growth on the walls n may run as high as .020. Other observers report similar results, all data going to show that $n=.015$ is as low a value as can be expected for pipe sewers 18 ins. diameter and larger. Clean and well-built brick sewers of 24 to 36 ins. diameter give a flow approximating $n=.015$. Larger brick sewers give $n=.013$ and sometimes even less.

So far, then, as the writer can judge, large pipe sewers ordinarily well-laid cannot be relied on to give a discharge larger than that of ordinarily well-built brick sewers of the same diameter. Whether they give as much is an open question. It is out of the question to claim the largely increased capacity which pipe manufacturers give. In this opinion the writer is upheld by many engineers who have considered this matter. It should be stated here that the smaller sizes of pipe sewers give velocities higher than those found by Kutter's formula. The flow in pipe sewers is worthy of extended experimental work, but the subject is attended with difficulties which are not easily overcome.

REPORT OF THE COMMITTEE ON SURVEYING.

To the Illinois Society of Engineers and Surveyors:

GENTLEMEN: Your Committee on Surveying has, pursuant to the recommendation of last year's Committee, taken up the subject of "Plats."

A plat, as we all know, is a delineation upon paper of the field work of the surveyor or engineer, and it should therefore be as thorough and complete a reflection of the work as can be made by lines, words and figures. As one of our best surveyors puts it, "make it talk." "I would ten times rather have a complete plat than wade through numerous pages of field notes and hieroglyphics, and then not find what I want." No matter how careful and painstaking the surveyor or engineer is in making a difficult survey, which may have taken weeks to perform, the whole effect is lost when he presents a poorly executed plat thereof. To a great degree his work is judged by its appearance as put upon paper in the plat of same.

This report will treat of the surveyor's plat to be filed for record, which is in short what is termed the original document. This plat, as a rule, receives considerable handling and should be drawn upon tracing cloth (vellum) or parchment paper; the cloth being preferred as it stands the wear and tear better.

It would be inadvisable to suggest any particular scale upon which the plat should be drawn. This would be entirely governed by the size of the tract of land subdivided, the main object being to show all lots or divisions on a scale large enough to admit all lot numbers, dimensions, courses, areas, etc., to be clear and distinct and at the same time not crowded. Every surveyor cannot be a good draftsman, but he should certainly take pains to make his plat describe the land he subdivides. Any one searching the early records of any county, and occasionally he does not have to go back very far either, can testify to deficiencies, inaccuracies, omissions, etc., in the plats, causing endless confusion and often times litigation.

One of the chief sources of complaint is the almost universal occurrence of insufficient descriptions which fail to definitely locate the property subdivided. To illustrate: You find a plat recorded, the caption of which will read, "Tom Jones Subdivision of part of Block 7 in School Trustee's Subdivision of Section 16, Township 39, Range 14 East, of Third Principal Meridian." You will find the surveyor's certificate to read, "I, John Smith, do hereby certify that I have surveyed the above described tract of land and subdivided the same into lots, alleys, etc., and that the annexed plat correctly represents said subdivision." How is anybody to know what Tom Jones owned unless he takes it for granted that John Smith gave him what he was entitled to? Jones must certainly have a deed which describes his property, and the surveyor must have seen the same, for without it he would not know where to begin or end his survey. The caption of the plat would be accepted in the abbreviated form, as it in a measure identifies the block the property is situated in; but the surveyor's certificate should describe the same fully as conveyed, so as to completely identify it. Had the surveyor described the property as deeded in his certificate, or designated upon the exterior lines of the subdivision their location with reference to any particular established block line, it would have enabled the next surveyor to retrace the work of the first one, and also to know what part of block has been left unsubdivided.

It is conceded that in making a survey of a lot in a subdivision (government or otherwise) it is required to locate the lot corners where the original stakes or monuments were placed, and it is the duty of the surveyor who makes a subdivision to describe the land he has surveyed, and give the location of his initial point or points.

If the property is described by metes and bounds as part of a lot, block or quarter section, the surveyor should describe it so; and he should show upon the plat the location of the starting point with reference to the nearest corner of the lot, block or quarter section. He should also show any additional information that may help to restore any of the corners if obliterated.

If the subdivision has a Congressional description, being part of a quarter section, the surveyor should give the lengths of all the lines of that quarter section. If it became necessary to survey the section, he should give the lengths of all the lines measured by him; also show whether the quarter corners are in a straight line between the section corners. In this way a great help would not only be given future surveyors in retracing the old subdivision lines, but would also benefit the property owner, and in a measure prevent disputes and law suits.

The platting and recording of the angular measurements to perpetuate the direction of bearings of the principal lines of a subdivision is an important consideration in any well executed plat. The manner of recording such measurements where the space on the plat will permit of it, is to place the exact angle made by the intersecting lines near such intersection in a manner which will clearly and neatly indicate the angular variation of the lines. At times the data upon the plat will appear to better advantage if the courses are designated by bearings from a true or assumed meridian. Bearings from a true meridian, although desirable, are practically out of the question, except in rare instances where the extra time and expense can be given to the correct determination of a true meridian. For all ordinary description for plats or deeds an assumed meridian can be used as a base for bearings, but reference should be made in the description of the land to the fact that such meridian has been thus assumed and that the bearings have been given with reference to such meridian. This meridian can be made to coincide very nearly with the true meridian by use of the magnetic needle and making a correction for the magnetic declination for the time and place. However, such a meridian is not to be taken as a true meridian, yet by the use of such a base the data for the bearings can be intelligently placed upon the plat and used as a guide to future surveys. With the distances and bearings recorded upon the plat, an opportunity is afforded to future surveyors to verify by computations the correctness of the plat.

Your Committee suggests that it would be advisable to call the attention of the recorder and the examiner of subdivisions to the deficiencies and omissions occurring in plats, and ask them not to accept or approve such plats unless they meet the necessary requirements.

W. M. HAY, Chairman,
W. P. FEENEY,
EMIL RUDOLPH,
Committee.

DISCUSSION.

MR. L. Z. JONES: When I run across a plat on record in a section block it does not mean anything at all to me. I think all surveys should have a base line, or at least two stones in every block. We can work from these two stones, and find all plat subdivisions, and if the difference from the orginal is four or five inches too long we find it out when we measure from the first line. If it does not come out right we may conclude that it is caused by some variation in the length between the original chain and the one in present use. I think also that a surveyor's certificate which is sent to be recorded should be so complete that when some enterprising lawyer steals the original plat to keep in his office, the certificate on record will enable a new plat to be made from that certificate.

MR. J. L. CLARK: I think very differently from Mr. Jones about two stones; you want a dozen. Set a stone at every lot corner and soon every one is gone in the subdivision but two. My advise is to get all you think you will want and then double them.

MR. JONES: I agree with Mr. Clark, but I say that the old plats that just give you one land mark to go from are practically of no value.

MR. H. I. ORWIG: I have been very much interested in the report read by Mr. Hay, inasmuch as the making of surveys and plats for record is a part of my daily occupation. In our work we have occasion to make plats in nine or ten different States, each of which has a different law and requires different forms of certificates.

Some twenty years ago I had the honor of being a member of the Michigan Engineering Society. In every county in the state there were plats on record so deficient in details of description, distances, and so forth, that it was next to impossible to make resurveys of them. The Michigan Society took up this question and appointed a committee of its members to devise a plan that would insure the making of good and sufficient plats. The committee prepared a plan which was adopted by the State Legislature and which is the best law that I know of relating to plats.

The original plat was required to be drawn on muslin back paper 18x24 inches in size and on a scale of not more than 200 feet to the inch. The plat was required to show subdivisions of the section in which it was situated, and all distances, ties and other information necessary to enable a resurvey to be made. The original plat, when executed by the surveyor and the owners, and before it could be recorded by the county register of deeds, was sent to the Auditor General of the State, who carefully examined it. If in his judgment it conformed to the law, he affixed his certificate of approval thereto and returned it to the owners, who could then have a copy of the plat made and certified to by the surveyor and the Register of Deeds, which copy was placed on file in the Register's office. A third copy of the plat, showing the date of its filing in the Register's office, was then made and placed on file in the office of the Auditor General. After all this was done the owner was allowed to sell lots in his subdivision. This law placed the making of plats throughout the entire State under the supervision of the Auditor General. This is a far wiser plan than to leave it to the local Register of Deeds, who, though in most instances a person of intelligence and ability, yet is frequently without such a thorough knowledge of land descriptions as would enable him to properly judge of the sufficiency of a plat.

When the law went into effect it made a whole lot of trouble for some of the incompetent makers of plats. They had no end of bother trying to get their plats through the Auditor General's office. I should say right here, that it was largely owing to the efforts of the then deputy Auditor General, Mr. H. R. Pratt, one of the most careful and precise (as well as persistent) men I ever knew, whose rigid inspection of plats and strict enforcement of the law, made that law a success. I believe Mr. Pratt is no longer living, but his memory is certainly cherished by the older members of the Michigan Engineering Society, for the faithfulness with which he performed his part of the work. The Michigan law, has, I think, never been surpassed by any other state. The State of Mississippi has a law in some respects like the Michigan law, but lacking some of its important points.

PRESIDENT: I think the trouble with some of our early surveyors was that they followed the law literally. The law then and now says that the surveyor should put a stone as a permanent monument from which to mark future surveys and plats. That was the law in the early day and is yet. It is misleading, because he followed the law literally when he put a corner stone there, and the fault is in the law. It has been said that under the Michigan law the plat is pasted in a book. The law of Illinois states distinctly that it shall be recorded in a book, not pasted. The law is that a plat of all subdivisions shall be recorded in the Recorder's office, and if a recorder does not do it, he simply violates the law. The original plat is the property of the proprietor of the addition, and there is no one but the owner who has authority to have it, except those who record it.

I think it is now the rule of most surveyors in making subdivisions to mark substantially the corner of each block at least, and some even go further than that, and I believe it is the rule (at least it is the best practice) to mark all angles. Now that is in line with what every speaker has said, and it is very important. Often an angle will show an error, if there is an error in the original survey, then it is usually a reasonably easy matter to determine where the error is.

MR. JONES: Very often when a corner lot is sold the very first thing the new owner does is to carefully dig up that land mark and sets his fence post in its place, and then he declares, "I set that post just exactly where the surveyor set the original stone on the lot."

PRESIDENT: You are right in that, but you might add that the trouble is, he did not do it.

MR. JONES: If there could be some plan devised for setting monuments at the intersection of streets whereby the lot owner could have no excuse for disturbing the land mark or corner stone of which you speak, it would be of great value.

MR. H. I. ORWIG: The Chicago & Northwestern Ry. Co. owns several hundred town sites and we have occasion to make plats in a great many States. These are made uniform so far as the plats themselves are concerned, only varying the certificates to conform to the law of the several States. We follow the Michigan law as far as possible. I think Illinois has about the worst law I am working under, if you will pardon me in saying so.

G. W. BROWN: I think if some of the gentlemen will follow the rule we followed in Joliet you would have less trouble. We made a resurvey of the whole city and subdivisions and put in iron stakes 18 inches long. Each iron we witnessed by at least two or three objects, so that when at any future time any one wants a survey, you can go to a block corner (by having the witnesses to this corner) and thus save lots of work and trouble.

MR. W. M. HAY: Following that line of suggestion, I would like to bring to the notice of the Society the method which I have practiced at DeKalb, and have found very successful and satisfactory.

In surveying and resurveying, the practice I have inaugurated is to place a concrete monument at every block corner where we have made surveys. I use 4-inch sewer pipe and concrete, setting the pipe with bell end up and filling it with concrete. Before the surface of the concrete has set, a neat cross is impressed in the surface by a surveyor's tally pin. The surface is also impressed with a brass stamp bearing the word "Block," and another stamp bearing the word "Corner." The number of the block is also stamped in by brass cement stamps, using the proper combination of the numbers from 0 to 9. After the concrete has thoroughly set, these blocks are placed at the corners where the temporary wooden stakes were placed, and the corners are thus permanently and intelligently marked.

PRESIDENT: We have each found that a certain kind of monument bests suits the local conditions. In our city of Moline we have found an iron stake the most convenient. The dimensions I have used is a ⅞-inch round iron bar about 3 feet long; that is a monument that is easily set and can be easily reset. It is inexpensive in first cost and inexpensive to set. It can be driven almost as easily as a wooden stake, and can be lowered or raised as the case may be, and when we grade a certain portion of the street, we dig a hole and place this monument at the new grade before any excavation is done.

MR. W. M. HAY: I have a resolution that was drawn up by the Committee on Surveying. It is the outcome of a discussion yesterday on the subject of "Plats," and in our judgment the present law upon plats is not sufficiently strong.

RESOLUTION.

Resolved, That it is the opinion of the Illinois Society of Engineers and Surveyors that the present law in relation to "Plats" should require the surveyor's certificate to contain a correct description of the land subdivided and that permanent monuments of stone, iron or equally durable material be required to be set by the surveyor in number equal at least, to the number of angles in the exterior boundaries of the land subdivided.

THE MICHIGAN LAW ON PLATS.

(Note by the Secretary.)

As definite information respecting the Michigan law relating to Plats will be of interest in connection with the foregoing discussion, I wrote Mr. F. Hodgman (the Secretary of the Michigan Engineering Society) in regard to it. It appears that the original statute of 1885 was not promoted by the Michigan Engineering Society, and was not known to the Society until it was passed. The Society took it up later, and had it pretty well revised in 1887. As it now stands it is largely Mr. Hodgman's own work. In fact it was his individual work before the Legislature that brought it into the present shape, the amendments now standing as he wrote them.

The following is a quotation in regard to this law, from Mr. Hodgman's "Manual of Surveying:"

> In Michigan, town plats are required by law (Session Laws of 1885) to be made and recorded in the following manner:
>
> The plats must be made on sheets of good muslin backed paper, 18x24 ins. in size, on a scale showing not more than 200 ft. to an inch.
>
> The plat must have upon it a full, detailed written description of the land embraced in it, showing the township, range, section and subdivision of section of the land platted. If the premises platted are not included in the legal subdivisions of the government survey, then the boundaries are to be defined by metes and bounds and courses.
>
> The plat must contain the full name of the town, city, village or addition platted; the names of the proprietors and of the person making the plat, and the date. It must be signed by the proprietors and by the person making it, and be witnessed and acknowledged in the same manner as deeds.
>
> The sections and parts of sections must also be designated on the plat by lines with appropriate letters and figures. There must be a plain designation of the cardinal points of the compass and a correct scale.
>
> When complete, and before any copies are made from it, the plat must be submitted to the Auditor General for his approval.
>
> An exact duplicate of the original plat must be filed in the office of the Register of Deeds for the county in which the land is situated. It must contain all the matter in the original plat, and the certificate of the Register of Deeds and the person who made the original plat that they have separately carefully compared the duplicate with the original plat, and that it is an exact duplicate thereof and of the whole of such plat.
>
> A third copy must be filed in the office of the Auditor General. This copy must contain the certificate of the Register of Deeds and of the person who made the plat, that they have separately compared it with the duplicate plat on record, and that it is a true transcript therefrom and of the whole of such duplicate plat so recorded.
>
> The Register of Deeds receives a fee of $2 for recording the plat, and he sum of $1 must accompany the plat filed in the Auditor General's office.
>
> The law was amended in 1887 so as to require the surveyor to plant permanent monuments at all angles in the boundaries of the land platted, and at all the intersections of streets, or streets and alleys, as shown on the plat; and when there are permanent objects in the vicinity of such monuments, the bearings and distances of such objects to be noted. The character of the monuments and the bearings and distances of such objects or witness points must be given in the most convenient manner on the plat. The surveyor must certify that the plat is a correct one, and that the monuments described in it have been planted as therein described. The new provisions of the law are very important. The monuments are the crowning work of the survey, without which all else is of little value. They mark out the standard of measure on the ground, to which all subsequent surveys must conform. President Steele, of the Michigan Engineering Society, says:
>
> "Place more monuments instead of less. Place them everywhere, no matter whether at the intersections of streets at the side lines, the center lines, or any other lines. Put down all you can. Plant them in exact relation one to another. Put the bearing on every line, the angle at every intersection. Put it all on your plat, and the more you have the better. Leave nothing to guess at. Have it so plain that a man who never knew anything about the ground can go there and find all the points."

PLATS FOR BUILDING IN CITIES AND TOWNS.

DISCUSSION.

Topic—"The advisability of requiring owners of property in cities or towns who are about to build, to furnish a plat of survey together with their building plan to the commissioner or head of department whose approval of building plan is required.

MR. WM. P. FEENEY: The point in view at the time the suggestion was made to make this matter a subject of discussion was, that if owners of lots were required to furnish plats of surveys together with building plans to the building commissioner or head of department who approve building plans in those cities or towns which require the approval of such plans, it would have a tendency to lessen the complications and disputes arising over property lines. In other words, it would require the lot owner to have a survey made before he could build. One of the principal causes of disputed lot lines is that owners of lots attempt to survey and locate their own lots. For instance, take a man who owns a lot in the center of a block that contains 20 lots of 25 feet; suppose he is 250 feet from the corner of the block, which corner is determined by a stake or something he can be satisfied with. He will suppose that all that is necessary is to get a good steel tape and measure down 250 feet. He may possibly measure it twice to be certain that he is right. In a year or two perhaps his neighbor will want to build, and if he is a sensible man he will call in a surveyor. The surveyor will measure from block line to block line carefully and very likely will find a shortage or a surplus over the recorded distances. This he will divide, and consequently differ from the line established by the first lot owner. Litigation and a law suit follows; the surveyor's time is taken up, the public's time is taken up, and is very likely to make hard feelings between the lot owners. Then again, take it where original corners are found. We know that stakes found in the ground five or six years after a subdivision is made, are not always found where placed. Driving over them and frost have a tendency to push them one way or another, so that the stakes at lot corners will often show 1 inch or 2 inches more or less than the record.

I believe that if a law of this kind could be passed, not necessarily by the State, but by the cities and towns, civil engineers located in these different cities and towns could use their influence with the Councils if they felt disposed to do so, and have them pass an order that would require the furnishing of plats of surveys. This plan would help building commissioners in examining building plans to know whether a lot covers 25 feet or 24.5 feet, and I believe it would have a tendency to do away with disputes over property lines.

MR. L. Z. JONES: I think that is a pretty good idea, for the reason that if the original survey is old enough, it was probably made with the old chain that is 4 inches too long. Of course the difference does not amount to anything where land is only worth $40 an acre. But if the land is afterwards surveyed with a steel tape it would be found to be a long way out of the right place.

MR. WM. P. FEENEY: If a subdivision laid out in the summer time at a temperature of 90 degrees was again measured with the thermometer at zero, a vast difference would be found.

PRESIDENT: I think that usually this trouble does not come from the lot owner. It comes from the contractor, but owners, so far as I am able to judge, are quite rapidly taking the precaution of employing the better class of architects who see to it that a survey is made before they complete their plans and before they allow the contractor to go to work. I think the principle is all right; and I believe that is the place to put it, and is the least objectionable stand you can make. The architect is the man who should be held responsible. If the architect was in some way made to do his duty in the matter it would accomplish the result in the best way.

MR. L. Z. JONES: It would compel him to keep the building within the proper width of the lot.

PRESIDENT: The State Board could perhaps provide for it without any law. With certain modifications, where an owner did not go to his line with his building, it would not make any difference, but where he wants to cover the whole of his lot, the architect should be required to have a survey made, and the better class are already adopting that rule.

MR. WM. P. FEENEY: Another practice that should be stopped is this: The owner supposes that the contractor is taking care of all these things. He charges for surveys that he, the contractor, has made. He charges the owner for surveys that he has made, and sometimes the architect drawing up building plans proposes that the contractor shall furnish surveys. Now the lot owner does not know who makes the surveys until he has the plat of surveys.

PRESIDENT: But if it was brought up to the architect in some way that he would have full responsibility, do you not think it would be best?

MR. W. P. FEENEY: I think it would be easier for cities and towns to make that an ordinance; to provide that it would have to be made by a competent surveyor.

MR. L. Z. JONES: That throws the surveyor out from surveying his own land.

PRESIDENT: I think he is thrown out any way. In regard to this topic under discussion, if there are twenty lots in a block, it either calls for twenty surveys or one survey to cover all the ground and be placed on record where the architects can obtain it.

MR. CLARK: I would like to ask how much margin to allow in 100 feet in a change of temperature.

MR. FEENEY: About ¼ inch per 100 feet is the allowance for each 30 degrees change in temperature.

PRESIDENT: Of course if a steel tape is tested and certified, that certificate is for whatever temperature the test was made under. Now say you use 100-foot tape, there is a certain temperature at which these tapes are made standard.

MR. FEENEY: Experiments made covering a number of years has developed that each 30 degrees of change is equivalent to an expansion or contraction of ¼ inch to 100 feet. Some tapes are adjusted for 60 degrees, others for 65 degrees temperature, even tapes made by the same manufacturer. My own work I reduce for a temperature of 60 degrees.

THE PROPOSED CO-OPERATIVE SURVEY OF ILLINOIS.[*]

BY WM. H. HERRON.

Sentiment in favor of a topographic map of Illinois has grown steadily throughout the State since the subject was first discussed before the Society by Mr. W. J. Alvord a number of years ago. During the past two years this interest seems to have been so thoroughly awakened that a successful beginning in the near future appears very probable. Organizations, railway companies and educational institutions of the State, not heretofore posted as to the advantages within our reach, now realize the importance of this work and are giving it hearty and earnest support.

This Society has reason for self-congratulation upon being the first to suggest and to advocate this undertaking, which, when carried to a successful conclusion, will bring great benefits to the State and words of praise from all classes of its citizens. It is important at this present time that we take up the question in a careful way and become thoroughly familiar with the method of procedure proposed, the details of the working plan, and to fully realize the educational, scientific, and economic value of the completed maps to the general public, as well as to more special interests.

THE NEED OF A BASE MAP.

Engineers and surveyors throughout the State fully appreciate, I think, the urgent need of a base map which will, in a measure at least, meet our every-day demands.

The present maps of the State rest upon scattered land surveys, many of them made years ago, in the face of great obstacles. Atlases of many counties have been published by private parties, but most of them show discrepancies within themselves, not to mention their failure to join adjacent maps.

What we need is a "mother map" which will serve as a base for all future work, a survey of the whole State, with careful and accurate vertical and horizontal control, a necessary preliminary to other surveys where results need to be made a matter of map record, such as agricultural, meteorological, magnetic, engineering, biological, and geological surveys. The former geological survey of Illinois would have far greater value if its results could have been delineated upon a map such as is now proposed.

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[*] A somewhat similar paper, also by Mr. Herron, was presented at the annual meeting of 1901, and published in the Society's "Report" for that year. SECRETARY.

We have a wealth of valuable data relating to the State's physiography which is practically useless to us in its present chaotic condition. The work of the United States Coast and Geodetic Survey, the United States Lake Survey, the Mississippi River Commission and of the United States Geological Survey is not easily accessible because of the difficulty of assembling it. The usefulness of railway and other lines of levels of more or less accuracy, but with different datum planes, is also much diminished for want of a reduction to a common base. Much of this material is available and can be utilized in the proposed work and made to serve the public in an entirely practical way.

Mr. H. M. Wilson, when discussing public uses of topographic maps in his "Manual on Topographic Surveying," says:

"The whole system of making successive special surveys or maps for every new need is one of the most wasteful in our present public practice, nor can it be otherwise until one survey shall be made that answers all important official uses.

"The amount of money that has been expended in making small maps of numerous cities and villages would have mapped on a general scale many times the area of the country.

"Even when we have these special maps they do not fully answer the purpose for which they were intended, as they only show the small area included within the immediate plan of operations.

"The value of a stream for economic purposes cannot be fully ascertained by an examination of the stream at the point from which it is to be used, but the drainage basin from which it derives its supply should be surveyed and the area and slopes be known.

"A good topographic map not only shows the relations between the natural and artificial features in the immediate neighborhood under consideration, but it shows the relations of these to the surrounding country."

GENERAL FEATURES OF A TOPOGRAPHIC MAP.

Ordinary maps, as we know, take account of the horizontal extent of the country, locating objects according to their latitude and longitude. Topographic maps also show these features, but, in addition, indicate the relief of a country, showing the elevation of the whole surface above sea level, affording opportunity for comparison of its different parts. The slopes and shapes of the surface forms and all differences of elevation are indicated by lines of equal elevation, called contour lines, with an interval which is determined by the limitations of the scale of the map. The 500-foot contour line, for example, passes through all points that are 500 feet above sea level and represents what the shore line would be if the sea were raised 500 feet.

The National Government has for many years been publishing such maps through the topographic department of the United States

Geological Survey. A skilled corps of geographers, topographers, engravers, and printers has been developed, and much experience has been gained, not only by the makers, but also by the users, of these maps as to most convenient size and scale for such publications.

THE PROPOSED CO-OPERATIVE SURVEY.

The United States Geological Survey expends about $300,000 per year in topographic work, dividing its operations as equitably as possible among the different States and Territories. For a number of years the Director has consented to co-operate with various States in topographic work, and has contributed from the Federal appropriation a sum equal to that proffered by the State, it being understood that in all such work the general plans and methods of the Federal Survey cannot be set aside on account of State co-operation. It is against the policy of the Survey that work on important areas or subjects should be stopped in order that co-operation in individual States may be extended.

The Director is willing to enter into co-operative agreement only when the interest of the country as a whole will be benefited. The general policy and work of the Survey can be changed only by direction of Congress.

A bill similar to the one introduced in the State Legislature two years ago is again proposed, which authorizes a topographic survey of the State of Illinois in co-operation with the United States Geological Survey, authorizing the Governor to appoint a commission of three citizens of the State—who are to serve without salary—to confer with the Director of the United States Geological Survey or his representative, and to accept co-operation in the preparation and completion of a contour topographic map of the State, giving this commission power to arrange with the Director concerning the map, its scale, method of execution, form, and all details in behalf of the State.

It provides that said map shall accurately show the outlines of all townships, counties, and extensive wooded areas as existing on the ground at the time of the execution of the surveys; the location of all roads, railways, streams, canals, lakes, and rivers, and shall show by contour lines the elevation and depression of the surface of the country. It further provides for the first two years an appropriation on the part of the State of $20,000 each year, an equivalent amount to be expended by the United States Geological Survey.

From accurate estimates based upon a similar class of work in other States and taking into consideration the character of the topography in Illinois, we are assured that a map on a scale approximating one mile to the inch (publication scale) and a contour interval of 10 feet can be made for $8 per square mile.

Illinois has an area of 56,650 square miles, 4,435 square miles of which have already been surveyed, leaving the area to be mapped

52,215 square miles. At $8 per square mile, the total cost of the survey would be $417,720. Half of this amount would be expended by the United States Geological Survey, leaving $208,860 as cost to Illinois for a complete topographic map of the State. The co-operating expense to the State ceases upon completion of the final drawings made for the engraver, the Geological Survey bearing the expenses of engraving and publication.

It would be controlled horizontally by a system of primary triangulation (developed from the various accurate triangulation surveys already made within the State) and by primary traverse, and in this connection one exact horizontal position in every 10 square miles would be established; and vertically by a system of leveling whose maximum limit of error on main lines would be 6 inches to 100 miles. In connection with this branch of work at least one permanent bench-mark, with elevation marked to nearest foot, would be set in each township or equivalent area, and at least one recorded bench-mark of less permanent character in every three square miles.

The work would be published in atlas sheets, each of which would cover an area of land about 14 by 17 miles, or one-quarter degree each way. Where a city is divided by a meridian, a special sheet is printed with the city in the center.

Public culture, which includes the exact plan of every road, lane, path, railway, street, dam, public boundary, name, etc., is printed in black.

The hydrographic or water features are printed in blue, and include all lakes, rivers, streams, swamps, marshes, reservoirs, springs, etc.

The relief or surface forms are printed in brown, including the shapes of the hills, valleys, and ravines, their elevations and depressions, and the slopes of every rise or fall in the surface of the land.

The topographic maps produced by co-operative surveys are engraved on copper and printed from stone, and exemplify the highest type of map-making.

The co-operating States have the benefit of this publication without further expense, and the residents of the States as well as officials may purchase the maps at the rate of 5 cents per sheet or $2 per hundred sheets. This nominal charge is made by act of Congress to avoid expense due to indiscriminate distribution of the maps.

ADVANTAGES TO THE STATE IN CO-OPERATION.

The advantages of co-operation with the United States Geological Survey are so apparent that it seems hardly necessary to repeat in detail what appeared in my paper on this subject presented to the Society two years ago. With the Federal Government bearing half the expenses of field-work and practically all the expenses of administration and the publication of the completed maps, and furnishing us at once a corps of skilled topographers and field men, it seems to me that we have an alluring opportunity which should be immediately grasped.

Then, too, as a mere business proposition, attention may be called to the fact that the whole of the State appropriation and also about 60 per cent. of the Federal appropriation would be spent within the State and well distributed among the commercial and farming interests. With an available appropriation, an agreement between the Governor of the State and the Director of the Survey could be immediately drawn and field-work begin without the least delay. This would be impossible were we to undertake the work alone.

The State of Ohio began co-operative work but two years ago, and already the work is well started and some areas completed and maps engraved. As an illustration of the practical utility of the new topographic maps, let me quote the following newspaper item:

"A substantial saving in the cost of construction of a railway in Ohio, due to an unusual cause, has recently been reported. The saving to the road will amount to at least $80,000, and the cause was the timely publication of one of the topographic map sheets of the United States Geological Survey. During the summer of 1901 the Wabash Railroad was locating its line from the Ohio River across Jefferson and Harrison Counties, to a connection with the Wheeling & Lake Erie Railroad, near Falks Station. The same season the United States Geological Survey, through W. T. Griswold, topographer, was engaged in making a topographic map of the area crossed by the railway. This map was not available until the Wabash Railroad had completed its location and was letting contracts for building. When advance copies of the Government map, which was drawn with careful contours and altitudes, were obtained by the engineers, examination showed the possibility of a shorter route by leaving the main fork of Piney Creek and reaching the summit level by grades no more severe than those at first found. A new location was at once adopted and resulted in a saving of 2,300 feet in length of roadbed and a summit tunnel of 800 feet."

I have seen recently a copy of a letter from T. H. Loomis, Resident Engineer of the railway mentioned in the above item, at Steubenville, O., to Mr. W. T. Griswold, of the U. S. Geological Survey, which verified this report.

This but adds additional evidence as to the economic value of the topographic map. If one company can find one single atlas sheet worth $80,000 to them on one project, it does not seem unreasonable to assert that the public will get very quick and profitable returns from the money appropriated for this work. In fact, I believe it to be a matter of simple demonstration to prove that the money actually saved within a few years in various public enterprises would exceed the entire sum expended by this State for a complete map.

PEOPLE AND INTERESTS BENEFITED.

While this proposed work is advocated at the present time, principally by scientific societies, educators, professional and business men, its benefits will not be confined to those classes.

The committee of the Ohio State Academy of Natural Sciences, in its report to the General Assembly of Ohio upon a "Topographic Survey of Ohio," said:

"The pupils and teachers in every school district in the State will be benefited by having a full map of their own district at a cost of two cents a sheet. In present-day teaching the study of geography and of nature begins about home with the outdoor method. In some States, as New Jersey, every school in the State is supplied with a full set of the topographic maps of the State, to the great advantage of home work. All educational and scientific work up to the highest university courses will be greatly aided by having these maps as a base for recording statistics and observations of every kind.

"Agriculturists and land-owners will be benefited by having the relation of all farms and houses to the slopes and water drainage of the region correctly mapped. Bottom lands and hill lands, with their differing soils and adaptability to different crops, can be distinguished by the eye, and future record of soil analyses, temperatures, moistures, etc., which our agricultural experiment station is making, can be placed upon them, to the great advantage of farming industries in every county in the State. The timbered area will be shown; and, the survey being impartial, the maps will be of advantage to land-buyers and to land-sellers.

"All who use country roads and desire their improvement will be benefited. Farm wagons and pleasure carriages cannot be dispensed with, and the bicycle and automobile are creating a new urgency for the improvement of highways.

"Mining and quarrying interests, so far as they are affected by the surface features of the State, will be immediately benefited. But this advantage is preliminary to the possible greater advantage that will lie in the geologic maps which will follow the topographic maps at the expense of the United States Geological Survey. Upon these will be shown the coal, ore, building stone, and the like, with their true depth and distribution.

"Town and city people will be benefited in their sanitary engineering problems, such as providing for an unpolluted water supply and for the disposal of sewage. The water-courses involved are all correctly mapped and the flow of water is gauged. Not only will the preliminary expense of surveys for public works be very materially reduced, in many instances entirely saved, with an equivalent saving of taxation, but the liability of costly mistakes will be greatly lessened by the full information which is so easily accessible.

"Engineers, surveyors, and all whom they serve will be benefited by the fixed monuments scattered all over the State, showing position and elevation above the sea and furnishing definite starting points for all private surveying. By using these all private surveys will be connected into one system, and this will be important when cadastral maps are constructed as a basis for the correct assessment and taxation of land to give boards of equalization a fuller knowledge of the situation and quality of lands than they could otherwise possess. Also the most favorable locations for reservoirs, pumping stations, conduit lines, electric roads, steam railways, factories, canals, and all large enterprises that give life to business can be seen and suggested by such maps.

"Geologists, biologists, physiographers, and all investigators who work in outdoor science will be stimulated to redouble their activities by these maps. The laws that govern the distribution of plants and animals, and even the dwellings of men, can be better traced and understood if the maps are made.

"The military interests of the State and nation need these detailed maps. A military map, to be useful in the location of camps and forts for the mobilization of troops or for the fighting of battles, needs to show all the details of the surface. The predominant motive for the British ordnance survey and all the elaborate maps of Europe is the military motive. Military science is lame without such maps.

"The legislature of the State needs the maps for reliable information upon questions that may affect legislation.

"All the courts need them for guidance in certain cases.

"The State board of health needs them for guidance in sanitary decisions, and has had to spend money for hand-made maps for lack of them.

"The State board of agriculture, the State weather bureau, the State inspector of mines, the State board of public works, will all find them indispensable for their respective interests, and, through their improved facilities, the people of the State will reap the benefit."

The benefits and advantages so clearly expressed in the above report appeal with equal force to residents of Illinois, so nearly identical are the interests of the two States.

Finally, we have a high moral obligation upon us to contribute to civilization our quota of knowledge concerning our environment and conditions. We owe it to ourselves and to the world to publish all facts that will stimulate industrial enterprises, promote sanitary conditions, and add to the growth of education and science.

Massachusetts, Connecticut, Rhode Island, and New Jersey have completed State maps under the co-operative plan. Pennsylvania, New York, Maine, Maryland, Ohio, North Carolina, and West Virginia are at present engaged in this work. At least half a dozen other important States are agitating the question, and several are very near to the accomplishment of the desired legislation.

Procrastination upon our part may prove exceedingly disastrous, and I would urge upon each member of this Society hearty and active support of the measure now pending. Members of the Legislature of two years ago stated that there seemed insufficient demand for this work to justify immediate action. They will hardly urge that objection this year if all who are sincerely interested in the proposed work will but take the trouble to furnish members of the Legislature with full information upon the subject.

LIMITING THE SCOPE OF LEGISLATION.

To avoid complications in administration on the part of the United States Geological Survey, it is their desire, I believe, to make the bill as simple and clear as possible and to appropriate for topographic work only, and I sincerely trust that men engaged in other branches of scientific research and work will not jeopardize this initial undertaking by insisting that this bill shall make provision for work in other fields.

The topographic map will serve as a base for many lines of scientific investigation and stimulate systematic efforts in various directions, and it seems to me wise that all unite upon the single purpose of getting this foundation work completed satisfactorily before suggesting or insisting upon detailed features of superstructure.

If we are willing to do this and each make a personal effort to place the matter in a clear light before the public and its representatives at Springfield, I believe provision for the work of a topographic survey of Illinois can be made and operations begin during the coming spring—a work which, when completed, will reflect the greatest credit upon the people of our Commonwealth and present to the public a map equal, if not superior, to any yet produced by sister States.

DISCUSSION.

MR. JOHN C. QUADE: I should like to ask in just what shape that bill is to be presented; what steps have been taken and will be taken to present it in proper form to the Legislature.

MR. HERRON: I am not thoroughly informed as to just what has been done recently. I believe there has been some consultation in various parts of the State in regard to it.

MR. J. M. QUADE: I wish to state in regard to the maps, a catalogue can be secured indexing all these maps. They can be had, as stated by Mr. Herron, for 5 cents per sheet, or $2 per hundred from the United States Geological Survey.

PRESIDENT: I suppose most engineers are aware that the government issues a great quantity of that material, and if your Congressman will request it, the Department will send you notice from time to time when that material is about to be got out, with the prices. The prices are nominal, a few cents usually, and this matter is very interesting.

MR. QUADE: I think that most of the documents published now are placed under the supervision of the Superintendent of Documents. I have obtained a number of documents and have kept posted on those coming out, and a good many of the publications which the government is getting out are very interesting to engineers. There is a catalogue published monthly, but they are hard to get regularly. If you cannot get any particular one by asking through the Superintendent of Documents, you can get them through your Congressman.

PRESIDENT: By the request of your Congressman they will be sent to you very readily.

MR. QUADE: But they will not do it regularly. I have written several times. My Congressman wrote that they were figuring on placing them on sale at 75 cts. a year, but there are only a limited number of these publications issued.

MR. E. E. R. TRATMAN: I am informed by an officer of the Survey that a series of descriptive index circulars of the map sheets have been prepared and will be sent on request.

THE REAL ESTATE RECORDS OF A GREAT RAILWAY SYSTEM.

BY H. I. ORWIG.

The Chicago & Northwestern Railway Company owns about 8,000 miles of main line of railway, together with several thousand miles of auxiliary sidings, second track, and spurs to sundry industries. Together these make a total of perhaps 11,000 miles of railway, located in nine states, and touching about 1,500 cities and towns. It owns nearly 200,000 acres of land used for right-of-way and station purposes, and several land grants. These latter originally amounted to nearly three million acres, which are now, for the most part, sold to settlers. Its proprietary companies own more than 300 town sites and extensive tracts of land used for various purposes in connection with its business.

All matters relating to lands are in charge of a division known as the Land Department, which is presided over by an official having the title of Land Commissioner. This department employs a considerable force of men; including right-of-way and land agents, land examiners, timber estimators, surveyors, draftsmen, conveyancers, clerks, etc., each of whom has his special duties to perform. The department is charged with the transaction of all business concerning real estate, and with the custody of all land records, and to it are referred all matters in regard thereto. Inquiries are constantly being made in relation to town sites, right-of-way and other real estate matters; purchases and sales are continually taking place, and leases being made; and it is highly essential that the records be in such shape that they can be quickly referred to, and any information desired furnished without delay.

Maps constitute a highly important part of the department's records. Without correct and comprehensive maps it would be impossible to secure that degree of quick reference which is so essential to the prompt dispatch of business.

The various purposes for which maps are required necessitate many different kinds of maps. There are maps of right-of-way, of station grounds, land grants, town sites, gravel pits, and special maps of every description. There are all sorts and conditions of maps, of all sizes, to every scale, on all kinds of paper, and bearing the earmarks of every imaginable degree of servitude. Great care is exercised in the preparation of maps. They are compiled from surveys, and deeds or other instruments of conveyance, and are carefully checked to insure against possible errors. They are intended to show at a glance the exact status of the company's interest in the premises exhibited thereon.

The care of the railway right-of-way is an important part of the Land Department's work. There are franchises and ordinances to be secured; right-of-way, gravel pits and borrow privileges purchased; highways dedicated or changed, claims for damages to land or crops investigated, crossing contracts made with other railway companies, lands leased to industries, squatters kept off, and a long catalogue of other matters to be looked after.

The right-of-way title papers are kept in tin boxes holding from 60 to 100 deeds each, and arranged alphabetically by counties, each State having its separate section of the vault.

The deeds are filed in packages, each township and range by itself, and the deeds in the several packages arranged in numerical order by sections. There are a few exceptions to this plan, as in large cities, where the deeds are filed by wards or other convenient districts.

The maps of right-of-way are drawn upon mounted eggshell paper, usually 36 inches wide, and averaging a ten-yard roll to each county. They are constructed to a scale of 500 feet to the inch, and show the company's lands outlined in accordance with the descriptions in the deeds. All distances, courses and references are noted in full. The maps are colored to indicate the nature of the ownership; red signifying that the lands are owned in fee; brown denoting a borrow privilege; yellow that the title was gained by condemnation proceedings; green that the lands are owned by one of the proprietary town site companies; blue that it has been sold, and so on.

The maps show the name of the company's grantor. They also show the kind of title the company gained; that is, whether a warranty or quitclaim deed, a condemnation, an easement, borrow privilege, or lease, together with a brief note of any conditions limiting the company's title, or requiring it to perform specific acts.

These maps are in continuous rolls, by counties, and are kept in pigeon holes. They are arranged alphabetically by counties, and in sections by States, in the same manner as the deeds. Maps of station grounds, and of right-of-way through cities and towns are drawn on tracing cloth to a scale of 100 feet to the inch. These show, in addition to the right-of-way, all tracks, buildings and other improvements.

Permanent right-of-way maps are never made until after the lines have been constructed. In the building of new extensions it is frequently desirable to make changes in the alinement, and consequently in the right-of-way, and it has been found advisable to defer making permanent maps until after construction is completed. A blue print of the location map is used in the meantime to show the right-of-way, and such changes as are made while the work is being done.

While maps, right-of-way as well as all other, are very properly classed among the most important records, their principal value is in their use as abstracts indicating the kind of ownership, and as indices assuring quick access to the deeds, agreements or other papers under which the company claims title to each parcel of land. For it should be remembered that in all cases involving ownership, sufficiency of title, or other questions of importance, the title papers are always referred to.

For the keeping of town site records a different plan is necessary. The title papers of each town are kept in a separate package, and the whole set alphabetically arranged. The town site property is listed in ledgers; each tract, lot, block or outlot, being entered as for sale. There are columns in which to record the names of the purchasers and their addresses, the serial numbers of the deeds or contracts, the price, and the date of sale. At the head of the schedule of each town is a complete map of the town site, a faithful compilation of all the surveys and recorded plats thereof, to a scale of 200 feet to the inch, showing the entire tract of land originally owned by the town site company, the railway lines, right-of-way and station property, and all additions, vacations and sales. This map is always kept corrected to date.

Besides the map in the book there is also a tracing of it kept corrected to date, from which blue prints are made as may be required by agents, prospective purchasers, or others.

The steps usually taken in purchasing a parcel of land, for whatever purpose intended, are as follows: An option is taken from the owner, following which an inspection is made of his title. Then a description of the premises to be purchased is drawn, and a conveyancer prepares the deed for execution. After it is executed it is returned to the Department; and if properly executed, acknowledged and witnessed, it is delivered to one of the Department's engineers, usually not the one who prepared the original description. He rigidly inspects it, and if he finds it correct, colors and notes it upon the proper map or maps, indorsing it to indicate that he has so colored and noted it. After this it is entered in a register of land purchases, wherein are shown the names of grantor and grantee, the date of purchase, a brief description of the premises, the price paid therefor, and several other items of information. The document is then sent to the County Register of Deeds to be recorded, and when returned, is placed in an envelope, on which are noted the government subdivision, section, township, range, county and State in which the property is situated, together with the grantor's name and the nature of the instrument. After this it goes to join its fellows in the vault.

The deeds for lands sold go through the same process so far as the same is applicable to sales. When a sale is made, the deed or contract is given to an engineer or draftsman to outline and color the same in blue on the proper maps, and to enter thereon the deed or contract number. No deed is delivered to the purchaser without first having the proper indorsement thereon, indicating that it has been so shown upon the maps. The deeds for lands sold, whether of land grant lands, town lots, or portions of right-of-way, are consecutively numbered, and entered in a register of land sales which is kept on the same plan as the register of land purchases.

With contract sales, where the entire purchase price is not paid at once, contracts are executed in duplicate, one for the Department files and one for the purchaser. These are numbered in the same manner as deeds, except that each division of sales, land grant, town site or miscellaneous, is given a separate series of numbers, and filed separately. Standard forms of deeds are used for land grant and town site sales, and it is not necessary therefore to make copies of such for the files. But in cases of sales where the standard forms cannot be followed, the deeds are copied in full in a special record book.

Land grant lands are listed by forty-acre tracts or government lots in tract books, with columns for the purchaser's name and address, the area, the price paid, date of sale, and the deed or contract number.

The land grant maps are constructed on different scales, some showing on a small scale (usually half inch to the mile) the entire grant, and other special maps which show portions of the grant on various scales, according to the purposes for which they are to be used. Township diagrams are used to show the ownership, and large section maps to show the kind and quantity of timber on the several subdivisions. Beside these, there are sundry blanks which are filled out in response to requests from prospective purchases, and which briefly indicate the character of the land and timber thereon. At every station, portions of the station grounds are leased to persons for use as lumber yards, elevator and warehouse sites, or for other purposes in connection with railway business. The unplatted town site lands are leased for agricultural purposes, and occasionally some one encroaches with a building, fence or garden. Then, to avoid causing any hardship, as well as to protect the company's title, a lease is made of the ground so occupied, unless it is required for other purposes.

Several clerks are kept busy writing leases, which are made in duplicate, usually for a term of five years. They are numbered and entered in a record book in much the same manner as deeds, and also in a book called a "tickler," which is divided to show the year and the month in which the lease expires.

There are many other matters, such as highway and railway crossings, taxation maps, maps required by law to be filed in the Government, State or county offices; damages for overflowed lands, questions of accretions and riparian rights, encroachments, topographical and station ground surveys. Attention to all of these is the particular province of the Land Department.

REPORT OF THE COMMITTEE ON RAILWAYS.

Railway construction and improvement have continued actively through the year 1902. The mileage of new lines built amounted to about 6,000 miles; Illinois representing 140 miles or 230 miles according to two different records.

NEW TRANSCONTINENTAL RAILWAYS.

The days of new trunk lines of considerable length are practically over in this country, owing to the great network of existing railway systems, but one such line is now under construction. This is the Kansas City, Mexico & Orient Ry., projected by Mr. A. E. Stilwell, who a few years ago projected and constructed the line from Kansas City to the Gulf, which is now known as the Kansas City Southern Ry. The Kansas City, Mexico & Orient Ry. commences by a belt railway at Kansas City, and then runs southwest to Anthony, Kan., and Fairview, Okla.; thence south through Oklahoma and Texas to San Angelo, and approximately southwest across Texas and Mexico to Topolobampo Bay, on the Pacific. The boundary is crossed at Presidio, and the 125 miles of the Chihuahua & Pacific Ry. will form a part of the new line. With this exception all is new construction. The bay forms a landlocked deep-water harbor, and a town site has been laid out for the terminal point, which has been named Port Stilwell. The total length will be about 1,600 miles, of which 1,000 miles will be in the United States and 600 miles in Mexico. Grading has been completed at various points and aggregates 530 miles, while track has been laid on sections aggregating 175 miles. Construction work is in progress at several points, and a number of surveying parties are now at work making the final location for the intermediate portions. Time and money have been expended in securing a low-grade route, with a view to economical operation. Through Kansas the maximum grade is about 0.5 per cent; thence to the Rio Grande River (the international boundary) it is 1 per cent. On the mountain division in Mexico the maximum is 2 per cent., while on the Pacific slope it drops again to 1 per cent.

Another great railway project, which seems certain to be carried out, is that of the Grand Trunk Ry. extension to the Pacific, over a route lying north of the Canadian Pacific Ry. The Canadian government endeavored to induce the Grand Trunk Ry. to build to the Pacific coast long before the days of the Canadian Pacific Ry., but the company was then too conservative to undertake such a daring work. It now evidently believes that there is room for a second transcontinental line. The route will commence at North Bay (the present terminus of a line north from Toronto), and will terminate at Port Simpson on Bute Inlet. There will then be a direct line owned by one company from Portland, Me., and Quebec, Canada, to the Pacific. The Canadian Northern Ry. has been looked upon as projecting a transcontinental line, but this is likely to be dropped as a result of the action of the Grand Trunk Ry.

RAILWAY IMPROVEMENTS.

The general improvement of existing railways continues to be a very important feature of railway work, and a large amount of work of this class will probably be done during 1903, preparatory for the heavy traffic of the Louisiana Purchase Exhibition at St. Louis next year. This improvement work includes work of very varied character. From reconstruction of stations and yards, double tracking, and construction of concrete and steel bridges to replace older or weaker structures, it ranges up to the construction of diversions, cut-offs and practically new lines to effect improvements in profile and alinement. Many of these extensive and costly improvements are undertaken with a view to facilitating traffic under the modern conditions of heavy engines and heavy trains.

In regard to work of this kind it may be noted that on the Northern Pacific Ry., which has spent enormous sums of money in physical improvements to the line, no individual small work of this kind is now undertaken unless it forms part of the general scheme of improvement over a length of, say 500 miles. In some of the earlier grade reductions, work was done which had to be done over again, though being included in subsequent larger improvements. At the present time, therefore, long stretches of line are taken up for consideration, and their possible improvement carefully studied. If found desirable, a complete scheme covering the entire length is submitted. If it is approved, the various parts of the work may be done as a whole or piecemeal, as may be found desirable, but they will all eventually form part of the complete scheme.

RAILWAY SURVEYS.

A subject of particular interest to a society of engineers and surveyors is that of the methods of carrying on railway surveys for reconnoissance and location, and your Committee has therefore embodied in its report the following extracts relating to this subject, taken from a paper by Mr. Archibald A. Schenck, Division Engineer of the Chicago & Northwestern Ry., which was read before the Western Society of Engineers in December, 1902:

> A well defined reconnoissance or systematic examination and determination, in advance of instrumental survey, of controlling points appears to be undertaken by few roads over any large area. Apart from the general indications furnished by maps, and the suppositions of farmers, woodmen or Indians, but little preliminary information appears to be gathered, and no general determination made of numerous controlling altitudes and positions, before running the preliminary. In consequence, the running of preliminary

lines in actual surveys has been needlessly long and expensive. The method of location of most of our railways can more properly be termed a lack of any method. Each locating engineer has been allowed to take his own course, with no standard for different types of country. On some important roads one long preliminary line has been run through a valley already defining the route. Then the final location has been forced into place, sometimes aided a little by this preliminary, but generally far from it and unaided by it. A series of acrobatic performances in backing off and butting at the ground repeatedly with one curve after another, has been the substitute for systematic locating. If a preliminary has been run, the locating from it has been "from hand to mouth" work, in short sections. The locating engineer would go forth, return and remember "about where he wanted to be" with reference to the preliminary, and calculate his final location from his daily memory.

Contrasted with this has been the thoroughness of some roads in first grasping fully the topography, and all the topography of importance, of the proposed or possible routes, and placing the same fully on paper, where the broadest treatment could be given and the longest and best possibilities could be noted at one view. Either by contours, or by elevations in small figures at all important ground changes, the face of the country has been transferred to the paper. Line after line of experimental location has been quickly run off with pencil and dividers, the profile of each taken off and platted, its balancing examined and estimating made. A dozen long lines have been examined in an evening, which if run on the ground would have required days or weeks. Long stretches of tangent; long and snugly fitting, but light, curves have been secured, for both of which it paid to run through obstacles which the "memory" or "butting" process would have curved around. In effect, a thorough, close examination of each and every feature of each possible location is carefully made in advance of running any location instrumentally.

Such a system of topography and proper location, although generally heretofore used only in rugged country, is really needed even more in light, rolling country, such as that crossed by many of our so-called prairie lines. In such country a line can be run anywhere, with usable gradients. The best line can only be determined by a broad but close examination of long stretches or areas of country. In no way can this be done except by placing the country, approximately accurately, on paper, and studying the longer possibilities.

Entry of the topography upon the map in figures only has been found much better than to elaborate the contours before planning the location. If the figures are made small and distinct and entered in ink, many possible locations can be made in pencil and successively rubbed off after rejection. The elevations being taken at each important change of ground in each cross section, and the sections being taken to suit and develop the ground, the numerous small figures on the map make the best possible representation of the ground. They do not have to be thrown back into figures, as in the case of contours. Intermediate elevations can best be noted from such figures located at the ground changes, and grade elevations and their relation to ground elevation be most readily noted. Such a map closely resembles a coast survey map of soundings. After the location is adopted and inked on the map, the contours can be drawn in (having been interpolated), for the purposes of tracing the finished map. Meantime, there has been no confusion or obscuring of the penciled contours. The contours also can be more accurately determined in the office than in the field under conditions of wet, cold, hurry, etc. No ground need be needlessly contoured on the map, if this contouring is done after the final location has been decided. Figures at ground changes are more reliable than contours.

On branches of the Pennsylvania Railroad, nearly all the preliminary alignment was taken with the compass, with ball and socket joint; very little was taken with the transit. The balancing of small errors nearly always gave a result closer than any possible platting of the alignment or the location, even with the finest lines penciled in the platting, on scales of 400 feet or 200 feet per inch. The practical results when the location was run in with compass were found as good as if the preliminary alignment had been run in with transit. The saving of time in setting up, lightness in the compass when carried in rough timber, and the saving by setting only at alternate turning points where grade line was ahead, nearly doubled the rate of advance. In one respect the work was safer than transit work unchecked by compass, as no error would be carried beyond its own course, as with transit work, and affect increasingly all subsequent work.

The end area method of computation for earthwork has been found in use on most roads; the prismoidal method on very few roads. The middle areas were computed and entered in the books in red, on the latter roads. The use of the end area method was supported by several arguments. It was held to be fully legalized by custom, as in many similar cases giving quantities not to exact measure. The contractors' habitual prices and bids and profits were held to be based on quantities so determined, and that any reduction in average quantities would merely in time increase prices with no ultimate gain to the companies. Disputing the greater correctness of prismoidal methods to represent quantities was based on topographical reasons. Surfaces were held to be almost invariably convex in cuts, concave under fills, making actual quantities, through this rounding up or down between sections, greater than actual prismoids; and that the excess by end area method met these quantities which the cross sections failed to secure. Other roads introduced actual intermediate sections between the stations or ground change sections, reducing the excess from end area methods to insignificant errors. Corrections for curvature were rarely made.

In regard to field work and camp arrangements, nothing except an overbearing or over-threatening superior, can more quickly neutralize the company's cash expenditures for wages and convert willingness into the reverse, than poor equipment and supplies when the company agrees to furnish them. Their cost (as also that of expense accounts on settled lines of roads) does not aggregate much compared with the total of a pay roll; but every dollar spent for reasonable subsistence or expenses counts double generally any dollar on the pay roll. On some roads a special commissary agent was employed for large camps, relieving the engineer of all camp work during movement of camp. On the day of moving, the engineering work went on as usual. The party reported in the evening at the new camp, finding the evening meal ready, bedding (of boughs or otherwise) arranged, and the baggage of each man placed in his tent.

The limit of transportation of supplies appears to have been often overlooked, as a determining factor, reducing engineers to very low diet, and contractors and companies to very low treasuries. In a country where food for horses grows there is almost no limit of transportation. Where no feed grows, an absolute limit exists. The pack horse generally is the first means of transportation of supplies in large quantities, in wild countries. Assuming for his food a minimum of 20 pounds per day, and that he can carry 200 pounds, in a round trip of ten days he will eat his pack off his back, delivering nothing. The limit is a time limit, the distance depending on trails and weather. Approximately an average of 50 miles might be assumed as a limit in a country without feed, for delivery of substantial quantities of goods by pack horse. A slow method of storing gradually surplus amounts of feed along the route may extend the distance a little, at large expense. When pack horse limit has been reached, it is necessary to await the advent of the wagon road.

ELECTRIC RAILWAYS.

The subject of long distance interurban electric railways has been discussed in former reports, and our convention city is a terminal point upon one of the most substantial and elaborate of roads of this class. This is the third-rail line from Aurora to Chicago, a paper descriptive of which will be presented at the meeting. An example of the smaller class of interurban electric railways is the line from Sycamore to DeKalb, about seven miles in length, and built upon its own right of way. It is laid with old 60-pound rails from the Chicago Great Western Ry., and the use of these rails was permitted in brick paved streets without proper consideration of the effect of the combination. The rails are only about 4 inches high and the paving over and between the ties forms a series of waves. This is mentioned as a suggestion that permission to lay rails or track in streets should not be granted until a plan of the character of construction has been examined and approved by the city engineer or some other competent engineer independent of the railway company. The serious question of grade crossings of steam and electric roads has been presented in a paper prepared for this meeting by Mr. F. P. Ewald, Consulting Engineer of the Railroad Commission.

RECORDS OF RAILWAY WORK.

It is of great importance that records of work, whether for construction or improvement, should be kept in such a way as to allow of an analysis of cost of various items. As a rule, however, very few such records are available. Mr. L. P. Atwood, a member of this committee, has furnished particulars of his work-train records, which have been put in the shape of a separate paper for this convention. It is also of interest to note that Mr. Byers, the Engineer of Maintenance of Way of the Baltimore & Ohio R. R., has been appointed assistant to the General Manager with the specific duty of investigating and analyzing the accounts of the various departments, with a view to simplifying the method of accounts and reports, and of introducing economies in this direction.

E. E. R. TRATMAN, Chairman,
L. L. TALLYN,
L. P. ATWOOD.

THE DUTIES AND WORK OF THE CONSULTING ENGINEER TO THE RAILROAD AND WAREHOUSE COMMISSION, STATE OF ILLINOIS.

BY FRANK G. EWALD.

In the preparation of this paper, the duties and work of the Consulting Engineer to the Railroad and Warehouse Commission might be described in one sentence. But in order that you may have a better understanding of the nature of these duties, you will pardon the introduction of such references to the Commission, or to laws applicable to their duties, which may be pertinent to the subject. The legislative Act approved April 13, 1871, in force July 1, 1871, provides substantially as follows: The appointment of a commission by the Governor, to be known as the Railroad and Warehouse Commission, said commission to be composed of three persons who shall hold office for a term of two years, or until their successors are appointed.

Among other things, this Act requires every railway company incorporated or doing business in this State to submit to the Railroad and Warehouse Commission, an annual report for each fiscal year ending June 30, showing substantially as follows: The amount of capitalization; a complete statement of earnings and expenses; a statement of all mileage owned and operated, and the characteristics pertaining thereto; a detailed statement of passenger and freight traffic handled, and such additional statements which this Act specifically requires, or which the Commission may deem proper.

This Act also requires the Commission to investigate the cause of any accident on any railway resulting in the loss of life or injury to person or persons, which in their judgment shall require investigation.

It also authorizes the Commission to assume general supervision over the physical condition of all railways; to examine into the management of the business of all railways and warehouses so far as the same pertain to the relation of such railways and warehouses to the public, and to the accommodation and security of persons doing business therewith; and to determine whether such railway companies and warehouses comply with the laws of the State now in force, or which shall hereafter be in force concerning them.

It also requires the Commission to submit an annual report to the Governor on or before December 1st of each year, concerning the operations of railways and public warehouses in their bearings upon the business and prosperity of the people of this State, and such suggestions in relation thereto as to them may seem appropriate.

In addition to other Acts of the Legislature as bearing upon the subject of this paper, and which will be referred to later on, the Railroad and Warehouse Commission is vested with the authority to regulate public warehouses, and the storing of grain and inspection of same; to establish grades for grain; to prevent extortion and unjust discrimination, and to adopt a schedule of reasonable maximum rates; and other duties which are not necessary to mention here as they are not germane to the subject.

As above stated, the Act creating the Railroad and Warehouse Commission requires it not only to examine into the business operations of railways, but also requires it to make an inspection of the physical condition of the property. Inspection trips for this purpose are made annually, it being the aim of the Commission to cover about one-half of the railway mileage of the State each year. On these trips the Commission is usually accompanied by the Consulting Engineer, who is required to observe and examine in such a matter as to justify the ends, and consistent with the time allotted, the condition of all track, and the character of material contained therein; the condition of all bridges, stations, and buildings used for public purposes; to note also whether all frogs and switches have been properly blocked; to note the clearance of all overhead and side obstructions; to note the character and condition of right-of-way fence; to note the condition of the right-of-way with respect to cleanliness and combustible materials; to note also the condition of all farm crossings, approaches to highway and street crossings, and crossing signs.

The time usually consumed in making an inspection of each road varies from one to six days, a great deal depending on the character of the road and the number of miles to be covered. As the inspection progresses, notes are kept concerning the existing physical conditions as above noted, which are used later as a basis for a report to the Commission, and published in the annual report. For the lack of time and assistants these inspection trips are usually of a superficial nature, but the experience one gains in connection with the department of maintenance-of-way, serves as an expedient in a measure and enables him to observe the existing conditions very closely.

Under instructions from the Commission, the Engineer is also required to investigate all accidents on railways. The numerous other duties required of the Consulting Engineer forbid the investigation of all such accidents, but the more serious ones are looked after as soon as he may become advised. In case of a serious accident, an immediate visit to the scene is usually the first important step, in order that he may pursue his investigations understandingly, whether it be carried on independently or in connection with the railway company's investigation. The results of these investigations are also submitted to the Commission in the form of a report, but are not published.

The Act approved May 27th, 1889, provides that after July 1st of that year, any railway company desiring to cross with its tracks the main tracks of another railway company, shall construct the crossing at such place and in such a manner as will not unnecessarily impede or endanger the traffic upon the railway so crossed. In case of objection to the place or mode of crossing, either party may apply to the Railroad and Warehouse Commission, whose duty it shall be to view the site of the proposed crossing, set a day for hearing of evidence, and finally give a decision prescribing the place and manner in which such crossing shall be made. In such cases, the Consulting Engineer is also required to accompany the Commission in viewing the site of proposed crossing, in order that he may prepare any plans, submit estimates, or furnish an opinion concerning any engineering feature in connection therewith, if called upon to do so.

The Act approved June 2, 1891, provides that any railway company whose main tracks are crossed by the main tracks of another company, and which desires the crossing to be protected with an interlocking device, may petition the Railroad and Warehouse Commission for an order to provide such crossing with a complete system of signals and safety appliances. A map showing the location of the tracks involved must accompany the petition. All the railway companies interested are duly notified, a time is set for viewing said crossing, and at an agreed time thereafter the case comes up for hearing before the Commission and a decision is rendered. Or, if the Commission shall from information contained in any manner, have cause to believe that any such grade crossing is dangerous to the public or to persons operating trains over same, the Commission may, of its own motion, cite the several railway companies owning or operating the tracks forming such crossing, to come before said Commission at such time and place as may be named, and show cause why such crossing should not be provided with the necessary safety devices.

In either case, the Consulting Engineer is usually called upon to accompany the Commission in viewing such crossings also; in order that he may be prepared to submit engineering information in connection with the case, providing he is called upon to do so. After the Commisssion has finally promulgated its opinion concerning the installation of any interlocking device, the railway companies interested submit in duplicate plans of the proposed interlocking device for approval; or such plans may emanate through mutual understanding or agreement between the companies interested concerning any crossing which they desire to provide with a system of signal and safety devices. In either event, the plans of any proposed interlocking system must receive approval before the work of construction is begun. If, in the opinion of the Consulting Engineer, the plans conform to the requirements adopted by the Commission, they are duly approved and the duplicate is forwarded to the representative of the companies interested. The other copy is retained in the office of the Commission. If the plans do not conform to the requirements of the Commission, the character of traffic passing over each respective road is taken into consideration with respect to location of derails and signals, and the plans are accordingly amended and the construction of the interlocking system must conform to the plans thus approved.

The Commission assumes no authority over interlocking systems other than those located at crossings, junctions, and drawbridges; and no such system can be placed in operation until the same has been duly inspected by the Consulting Engineer, after receiving due notice that the same is ready for inspection. Following the inspection of the interlocking device and acceptance of same, a complete report of the inspection is made to the Commission with the usual recommendations that a permit be issued, allowing trains to run such crossing without stopping. The permit provides, however, that the enginemen must have their trains under control in passing through the interlocking limits. That is to say, the speed of the train must be governed by the brake power at command. All railway companies are also required to file monthly reports concerning the condition of each interlocking system in which they are interested, and the number and character of all derailments that may have occurred during the preceding month. A record of such derailments is kept in the office, compiled and published in the annual report.

The work of compiling statistics from the regular annual reports submitted by railway companies was formerly done by the Secretary, but of late years it seems gradually to have devolved upon the Consulting Engineer to do this. There is also, of course, the usual amount of office work in the form of correspondence, and the maintenance of records pertaining to this department that consumes considerable time. The work above outlined not only covers the operations of steam roads, but includes the operation of electric interurban roads as well, when they are incorporated under the general railway laws of the State.

In conclusion, I would say that the foregoing represents a complete statement of the facts as called for in the title, and while I would be pleased to argue as a matter of information, the necessity for competent assistants in this department, I would not only be transgressing upon the limits of this paper, but upon your time also. With the rapid strides which are being made in the construction of the electric interurban lines, and taking into consideration also the power vested in the Railroad Commissions of some of our other States as compared with that of our own Commission with respect to the indiscriminate construction of railway properties, and other matters, there is urgent need of revised and additional legislation.

DISCUSSION.

MR. E. E. R. TRATMAN: One point that suggests itself to me in connection with Mr. Ewald's paper, is that of grade crossings. With the development of the electric interurban railway, there has come a rather alarming increase in railway grade crossings, for it has been too often assumed that the grade crossing of an electric road with a steam road is much less dangerous than a crossing of two steam roads. This is by no means the case, for the electric cars usually run much more frequently than the steam trains, and therefore the liability of accident is directly increased. Besides this, there is the liability of the electric car losing its trolley or contact while on the crossing, and in fact there are numerous dangers incidental to these crossings. In view of the fact that the dangers of steam railway grade crossings are now pretty well recognized, and that vast sums of money are now being spent to avoid or remove such crossings, it is not reasonable to allow the increase of steam-electric crossings to go on unchecked. Of course, they may be protected by interlocking plants, but even if the new electric road pays all the cost of installation and operation, it is not always right to require an old established road running a service of fast trains to be subject to the liability of having these trains checked at inconvenient points to let an electric car pass. And no protection of a grade crossing is as safe as the absence of that crossing. In many cases, electric roads intending to operate a high speed service have purposely avoided railway grade crossings by the construction of viaducts, bridges and subways; partly on account of safety and partly to avoid the checking and stopping of their cars at the crossings. This might be done in many more cases, and there should be some power to compel it to be done where public safety demands it. In New Hampshire and some other States, electric railways are empowered to purchase land for the avoidance of grade crossings, so that they may turn off the street or road for this purpose. In Connecticut, the law forbids grade crossings of electric and steam railways. In Michigan, the Railway Commission has power to forbid them, and exercises this power freely. The Aurora and Chicago electric railway operates cars every half-hour and these cars run at 40 to 50 miles an hour, or even more. This is an example of the modern interurban electric railway, and the dangers of grade crossings on such lines are evident.

MR. J. G. MELLUISH: If I remember the paper rightly, Mr. Ewald makes some recommendation as to the enlargement of the powers of the Railway and Warehouse Commission, urging some changes of the law or revised legislation. I have an acquaintance with two of the Commissioners, and I know of one or two suggestions they would like to have embodied in the law regarding railways, that is, in regard to grade crossings with steam roads and electric roads, by requiring them to be at different grades, having compulsory power, as is done in New York and Massachusetts, by an amendment to our statute so as to compel roads where necessary, to cross at different grades over these roads. I think it might be well for this Society to recommend or to endorse such an amendment as that in view of this paper of Mr. Ewald's.

PRESIDENT: I would suggest that you prepare something in writing and offer it.

At a subsequent meeting, Mr. J. G. Melluish offered the following resolution, which was adopted:

RESOLUTION: GRADE CROSSINGS.

It is resolved by the Illinois Society of Engineers and Surveyors at its Eighteenth Annual Meeting, in Aurora, Illinois, January 22, 1903, that it recommend to the Legislature of this State an amendment of Section 114, Paragraph 156 (Starr and Curtis revised statutes), which shall give the Railroad and Warehouse Commission power to enforce the elimination of crossings at grade, both of existing and prospective crossings of steam roads with steam roads, steam roads with electric roads, electric roads with electric roads, and that the cost of the elimination of existing grade crossings which the Commission may from time to time decide to abolish, should be equitably apportioned between the railroads, State and town or city.

J. G. MELLUISH,
Chairman of Committee.

SECRETARY'S NOTE.

Copies of this resolution were sent to the Railroad and Warehouse Commission and to some of the daily papers. A letter from Mr. Kilpatrick, Secretary of the Commission, is given below, together with two editorials from the Chicago "Tribune:"

Dear Sir: This is to acknowledge receipt of yours of the 6th, transmitting a copy of the resolutions adopted by the Illinois Society of Engineers and Surveyors at its 18th annual meeting, held in Aurora, January 22, 1903. I am sure the Commission will be pleased to know the action of your Society in this regard, as it endorses the recommendations made by this Commission to the Governor and they will, no doubt, be much pleased if you would use the utmost endeavors of your Society to have the subject matter of your resolutions enacted into the statutes of this State. Whatever you may be able to do to further the enactment of the subject matter of your resolutions into the statutes of the State will be appreciated by the Commission.

Respectfully yours,
WM. KILPATRICK,
Secretary, R. R. & W. Com. of Ill.

NO MORE GRADE CROSSINGS.

The interurban electric railways of the State object to the proposition that they be put under the jurisdiction of the Railroad and Warehouse Commissioners. One great objection is that the Board does not allow a new steam railroad to cross an old one at grade. The electric roads fear the salutary regulation may be enforced against them when they extend their lines. As they are the newcomers they will be compelled to go up in the air when they cross railroad tracks. Construction will be made a little more expensive, and in contemplating that the electric railroad men lose sight of the greater safety of passengers when there are no grade crossings.

Before many years northern and central Illinois will be covered with a network of electric lines, doing an enormous passenger traffic. So far as that traffic is concerned the electric roads are already formidable rivals of the steam roads, which do not carry so many passengers to-day as they did a few years ago. The electric roads combine high speed and lower rates of fare. The steam railroads will be crossed at hundreds of points by the future electric roads. If the crossings are at grade there inevitably will be such accidents as there have been in this city. In many of the accidents there will be as great a loss of life as there was in the one which happened recently at Newark, N. J., where seven persons were killed outright.

If the general assembly does not see fit to put the electric roads under the jurisdiction of the Railroad and Warehouse Commissioners, it should at least enact a law providing that no such road hereafter to be constructed shall cross a steam road at grade. The general assembly will do this if it have regard for human life. Accidents are continually happening at guarded city grade crossings, and they certainly will happen at unguarded country crossings. Now is the time to make their occurrence impossible.—Chicago "Tribune," March 6, 1903.

NO MORE GRADE CROSSINGS.

A few days ago The Tribune called attention to the need of legislation to prevent electric interurban roads crossing steam railroads at grade. A correspondent sends a copy of a resolution adopted by the Illinois Society of Engineers and Surveyors at its annual meeting held a month and a half ago. The resolution asks the general assembly to—

"Give the Railroad and Warehouse Commission power to enforce the elimination of crossings at grade, both of existing and prospective crossings of steam roads with steam roads, steam roads with electric roads, electric roads with electric roads, and that the cost of the elimination of existing grade crossings which the commission may from time to time decide to abolish should be equitably apportioned between the railroads, state, and town or city."

It is gratifying to know that a society of experts, recognizing the dangers of grade crossings, has taken the matter in hand and is exerting its influence to prevent the establishment of death traps throughout the state. It is not expedient, however, to give the Railroad Commission power to abolish existing grade crossings, so far as Chicago is concerned, and to apportion the cost between the railroads and the municipality.* The removal of grade crossings is a matter the city is able to attend to and is attending to as fast as it can. It has induced the railroads to do a great deal of track elevation, and the roads have paid all the bills—as they ought to. In eastern cities the roads have borne only a part of the cost. Here the practice is different and will continue so. Chicago does not need the services of a railroad commission to apportion expenses.—Chicago "Tribune," March 12, 1903.

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*N. B.—The resolution refers more particularly to interurban lines.—SECRETARY.

THE WORK OF THE TESTING LABORATORY OF THE CHICAGO, BURLINGTON & QUINCY RAILWAY AT AURORA.

BY MAX H. WICKHORST.*

Mr. President and Gentlemen: I was asked to make a little talk on the testing laboratory at Aurora, and I appreciate this honor very much.

The testing laboratory of the Chicago, Burlington & Quincy R. R. was established chiefly for the inspection of materials, for getting up specifications for materials, and the inspection of such materials to see that they meet the requirements. But in addition to this inspection work, a great deal of special work has been done. For instance, the testing of various apparatus, such as pneumatic tools, injectors, etc., and the testing of locomotives for steam distribution, steam consumption, coal consumption, etc. We have, as nearly all other roads have, printed specifications for the great bulk of important material, such as car axles, boiler steel, and other material. In the case of material such as boiler steel, wheels and axles, the practice is to send an inspector to the works, who inspects the material there, accepts it at that point, and it is then sent to its destination. Other material when it arrives at the storehouse, the storekeeper in charge takes out a sample and sends it to the laboratory here at Aurora, where it is tested.

Then we pay a good deal of attention to boiler water. In selecting a source of supply, where there are several sources available, samples are always submitted for analysis, and the location of the supply is determined very largely upon the result of these analyses.

Going further along this line of water supply, the railway company is now putting up a number of water softening plants. There is one at Buda, Ill., and they are at present putting up others at Mendota and Aurora, Ill. It is possible that in the course of a year or two the company may have some more plants of this kind erected, the idea being to furnish the boilers with soft water, that makes practically no scale. The hard waters not only give trouble from the scale deposit, requiring considerable extra expense annually for boiler repairs, boiler washing, and loss of engine service; but it also tends to make the boilers leak very badly; that is probably their most serious trouble. In using hard water it is a very difficult matter to keep boilers tight enough to handle the business in satisfactory shape,

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*Engineer of Tests; Chicago, Burlington & Quincy Railway, Aurora, Ill.

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and this is probably the most important argument we have in favor of water softening processes for treating the water before it is delivered to the engine.

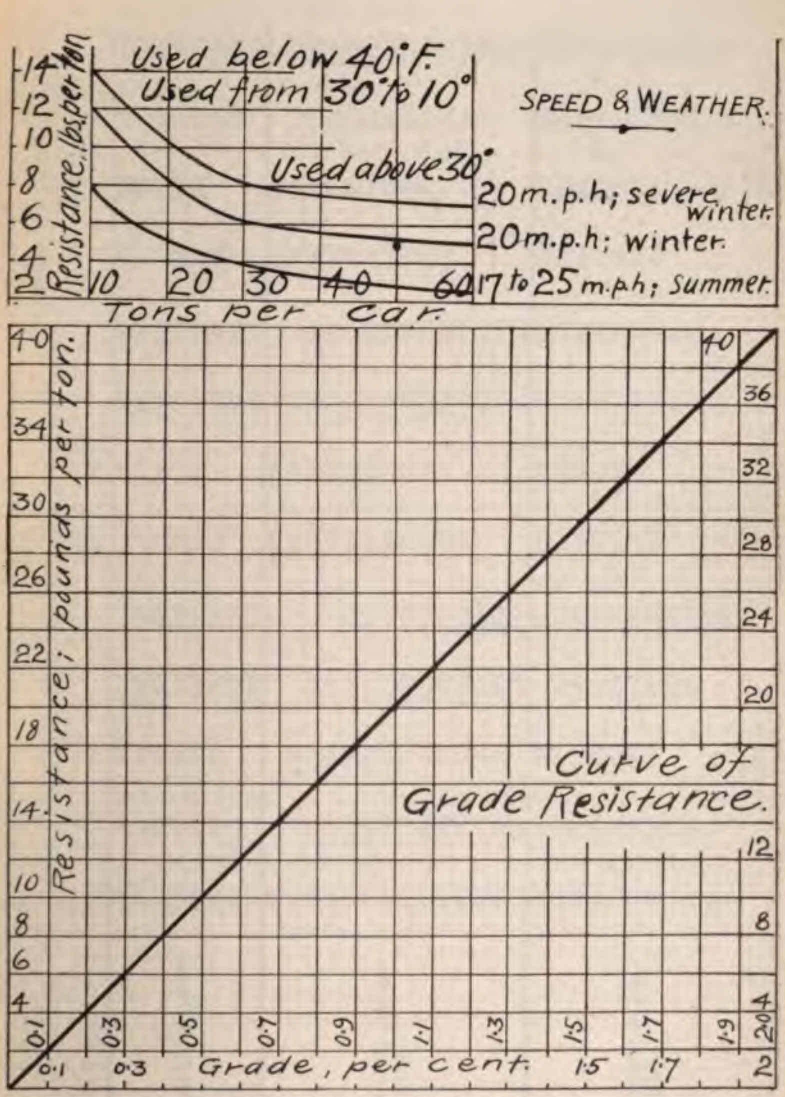
In the matter of train resistance, we have in times past done more or less work on the subject of train resistance and application of results to the rating of locomotives. Train resistance consists primarily of three components: First, acceleration, which is definite and can be calculated; second, grade resistance, which also is definite, knowing the grade; and third, friction, which is a compound, composed of a good many factors and varying with a good many conditions. The accompanying table shows the composition of train resistance:

Train Resistance.	Acceleration resistance, depends on tonnage only.			
	Grade resistance, depends on tonnage only..............	20 pounds per ton for 1 per cent. grade, or about 0.4 pound for each foot of grade.		
	Friction.	Journal, depends on design and lubrication.		Varies from 2¼ to 12 pounds per ton.
		Rolling, depends on solidity of roadbed.		
		Flange.		
		Curve.	A. Sliding of one tread, in each pair, on the rail.	
			B. Flange friction.	
		Side bearings and center plates cause flange friction.		
		Wind.	C. Wind against body of car.	
			D. Flange friction.	

Note—Flange friction consists of that due to curves, to side bearings and center plates, and to wind, etc.

I also present a diagram showing curves of friction or moving resistance and grade resistance. Horizontally we represent the tons per car, and vertically the resistance per ton. The resistance of a car at any given speed decreases as the weight of the car increases. In a 10-ton car we might start with 6 pounds per ton, and drop to 2½ pounds per ton for a 60-ton car, at the ordinary freight train speed of 15 or 20 miles an hour. These are just general figures. Now for the purpose of using that information in rating engines, we go at it something like this. The pull of the engine is a fairly constant quantity, and in making an engine tonnage rating we determine what the tractive force of the engine may be.

After determining the tractive force of the engine, the next problem is to balance this with just sufficient train resistance to equal the tractive force. The grade resistance is so much per ton, a definite quantity whether in empty cars or loaded. The frictional resistance varies and we get it from these curves. We get up tables showing the tons that will make the same total resistance, according to the



number of cars we have in the train. An example of these tables is given below, being taken from the time table of the Kansas City, St. Joseph & Council Bluffs R. R., which is one of the constituent roads of the Burlington system.

TONNAGE RATING FOR ENGINES.

(Gross tonnage of train exclusive of way car.)

		RATE A				RATE B				RATE C			
	Cars	A1	A2	H1	H2	A1	A2	H1	H2	A1	A2	H1	H2
Murrays and Kansas City	50	500		665	775			550	645			505	590
	45	515		680	790			565	660			520	605
	40	530	450	695	805	440		580	680	400		535	620
	35	545	465	715	825	455	385	595	700	415	350	550	640
	30	560	480	735	845	470	400	615	720	430	365	565	660
	25	580	495	755	870	490	415	640	740	445	380	580	680
	20	600	515	780	895	510	435	660	760	465	395	600	700
	15	625	540	805	920	530	455	680	785	485	415	625	720
	10	650	565			555	480	705	810	510	440	650	745
Murrays and Council Bluffs	80	895		1250	1505			845	1020				830
	75	925	760	1290	1545			875	1050				855
	70	955	785	1330	1590			905	1085			740	885
	65	990	815	1370	1635	675		940	1125			765	920
	60	1030	845	1420	1685	700		975	1165	575		795	955
	55	1070	880	1470	1740	730	595	1015	1210	595		830	995
	50	1115	920	1520	1795	765	625	1060	1260	620	505	865	1040
	45	1165	965	1575	1855	805	655	1105	1315	655	535	905	1085
	40	1220	1015	1635	1915	845	695	1155	1370	690	565	955	1135
	35	1275	1065	1695	1975	895	740	1210	1425	735	600	1005	1190
	30	1330	1120	1755		950	790	1270	1485	785	645	1055	1245
	25	1390	1175	1815		1010	840	1330	1545	835	695	1115	1305
	20		1235			1070	895	1390		895	750	1175	1365
	15					1130	950			955	810		
Bigelow and Villisca	45			555	620			475	530				495
	40			565	630			485	545			455	505
	35	420	360	580	645	365		495	560	340		465	520
	30	435	370	595	660	375	320	510	575	350	300	475	535
	25	450	380	610	675	385	330	525	590	360	310	490	550
	20	465	395	625	690	400	340	540	605	375	320	510	565
	15	485	410	645	720	415	355	560	625	390	335	530	585
	10	505	420	670	745	435	375	580	645	410	350	550	605
Corning and Clarinda		450	410			410	370						

Rating "A" governs under ordinary conditions when temperature is above 30 degrees; "B," when temperature is between 30 degrees and 10 degrees, or when weather is markedly windy or stormy; "C," when temperature is below 10 degrees above or in high head winds or very stormy weather.

Time freight and stock trains will ordinarily use "B" rating, and in favorable conditions "C" rating; but in very stormy or very cold weather will reduce tonnage so that approximately schedule time may be made.

Rating over Kansas City bridge should be carefully considered by Conductors, in asking for helper.

When an engine fails to haul its rating Conductor must telegraph Chief Dispatcher the cause of failure, and at end of trip Engineer must make written report to Master Mechanic.

DISCUSSION.

Question: Did you keep any figures as to the cost per 1,000 gallons for the water softening process?

MR. WICKHORST: The total cost will run up to about 3 cents per thousand gallons, in addition to the cost of the raw water.

Question: Is it based on the maximum quantity treated? You could not do it in small stations, could you?

MR. WICKHORST: That is the cost at Buda, which is now quite an important water station. Practically all trains going through there take water.

Question: Do you know how much is used there per day?

MR. WICKHORST: About 200,000 gallons per 24 hours. The plant we have at Buda is a chemical plant, on the Kennicott system. Its process is the one ordinarily used; that is to say, adding lime and soda ash to the raw water, mixed continuously with the water. The plant is composed of an upright cylindrical steel tank, with a steel cone inside. The water is admitted at the top of the cone in the tank and the chemicals are added at the same time. The water travels slowly down (the sediment settling at the bottom), and then rises outside the cone to an overflow at the top of the tank. The milk of lime is added for the purpose of removing any excess of carbonic acid, thus precipitating the carbonates of lime and magnesia. The soda ash is added to remove the sulphate of lime.

Question: Do you know how much chemical is used per gallon?

MR. WICKHORST: We use about two barrels of lime per day.

Note—A special test and dynamometer car is used for recording the drawbar pull of locomotives and the train resistance, for analysing the products of combustion of the engines, and for other similar investigations. It is 30 feet 9 inches long over the sills, is mounted on a pair of four-wheel trucks, and its principal equipment includes the following: 1, An oil-cylinder dynamometer for measuring drawbar pull and train resistance (the piston rod forming the attachment of the car to the engine tender, while the train is coupled to the other end of the car); 2, recording apparatus for making automatic diagrams of the train resistance, etc.; 3, an Orsat apparatus for analysing the smoke-box gases; 4, an air-brake recorder; 5, a steam pressure recorder; 6, a smoke-box vacuum recorder; 7, a Boyer speed recorder, electric counters, etc. This car is a part of the equipment of the laboratory department.

WORK TRAIN METHODS AND RECORDS ON THE RIO GRANDE, SIERRA MADRE & PACIFIC RY.

BY L. P. ATWOOD.

In view of the general interest in records of railway work and of cost of work, I submit a copy of my report to Mr. John B. Ramsey, General Manager, covering some embankment repairs made in the fall of 1902. The following statements will suffice to explain the report:

1. All prices are in Mexican silver dollars, worth 40 cts.
2. Laborers are very scarce.
3. Coal costs $11.25 per ton of 2,000 lbs.
4. Men worked from daylight to dark.
5. Flat cars 30 and 34 ft. long are taken to hold 8 and 10 cu. yds. respectively when loaded with all they will carry. This is the result of previous experience.
6. The dirt after being unloaded is left for section gangs to spread and dress, which is a small item in this work.
7. The method of loading and unloading with the same gang was followed because of the scarcity of labor and of cars.

In tie-renewals, since July 1, 1902, I have been marking all new ties with dating nails.

WORK TRAIN RECORD: SEPT. 11 TO NOV. 3, 1902.

Yardage Distributed on Kilos.

Kilo. 127	318	yds.	Kilo. 139	4530	yds.
" 128	1356	"	" 140	2244	"
" 135	86	"	" 141	1500	"
" 136	332	"	" 142	1202	"
" 137	640	"	" 143	1272	"
" 138	770	"	Siding	1722	"

Total yardage	15,972	"
Ave. haul (Kilos)	16.2	

Cost.

Pay rolls	$2,533.99
Train service (labor)	509.89
Engine service (labor)	678.13
Coal, oil, etc.	2,061.99
Tools, use of	22.67
Total	$5,806.67

Cost per cu. yd. (cents) 36.36.

Percentages.

Foremen Rustlingmen Clerical	10.50	per cent.
Labor	33.10	“ “
Train service	8.75	“ “
Engine service	11.65	“ “
Coal, oil, etc	35.45	“ “
Tools, use of	.55	“ “
Total	100.00	

Days Worked.

Train		50
Foreman, at	$4.00	67*
Foreman, at	2.00	50
Foreman, at	1.50	50
Rustlermen,	2.00	50
Laborers,	1.25	1537½
Water boy,	.75	50
Clerk		$30

*Waiting for tools. Custom house delay.

Miscellaneous.

Loading	1 pick to 2 shovels
Unloading	All men
Laying and moving pit track	33 days labor
Ave. no. cars per train	16

DISCUSSION.

E. E. R. **Tratman**: In filling trestles on the Nashville, Chattanooga & St. Louis Ry., careful account has been kept of the cost, and in a paper by Mr. I. O. Walker the following comparative costs have been given:

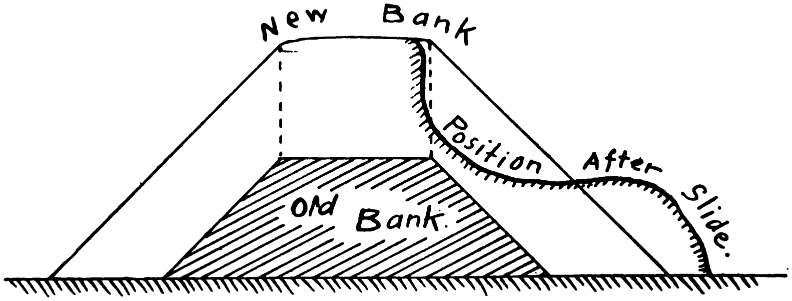
			Cost per lin. foot	
	Length	Height	Filled	Rebuilt
1	576 ft.	46 ft.	$....	$26.75
2	490 ft.	48 ft.	29.11	....
3	672 ft.	31 ft.	7.38	8.75
4	500 ft.	19 ft.	3.25	5.02
5	856 ft.	23 ft.	5.10	5.77

Mr. Walker estimated that trestles under 25 ft. in height can be filled as cheaply as they can be rebuilt, considering first cost only. It is true economy to fill trestles less than 50 ft. in height, if the waterway does not present exceptional difficulties, and where pipe or a small culvert can be used the showing will often be still more favorable than that given above. Of the above trestles, Nos. 2, 3 and 4 were filled by the steam shovel, at 10 to 14 cts. per cu. yd. No. 5 was filled by scrapers, by contract, and cost 14 cts. per cu. yd. No. 5 costs given in the table include borrow pits, pulling out old trestle, engineering, and also the hauling, handling, laying and spiking of ties. The cost of pulling out the old timber varies from 12 cts. per lin. ft. of trestle on long structures, to several dollars per foot for short isolated trestles.

STABILITY OF EARTHWORK PLACED ON OLD RAILWAY BANKS.

DISCUSSION.

MR. L. Z. JONES: I believe I suggested that subject, not that I am particularly interested, but as I live beside the Chicago, Burlington & Quincy R. R. I have noticed where they raised their grade about 17 feet on top of the old grade. The most of this was made of yellow clay below the top soil, and it slid away sometimes in masses 100 feet long after lying in embankment three years, and one place 30 feet long in an embankment 47 years old. The character of the filling and the slide is shown herewith. This clay seems to have some particular properties to be considered in engineering work. The ordinary "Because the book says so" rules do not apply. It seems to be devoid of sand. When dry it will stand vertically in the pit so that the steam shovel dipper teeth marks and the letters of the workmen's names cut with a jackknife can be seen for three years. In a spoil bank it has not settled in 47 years. Yet when it becomes wet it will not stay where it is placed, and even in the side of a cut with a 1 to 1 slope, where it has been undisturbed since the creation,



a little rain water at the foot of the slope will destroy its stability; a break will be made lengthwise and the slope settle down and leave a vertical wall. When completely settled its angle of repose is about the same as that of still water. In embankments the break occurs along the line where the ballast slopes deposit an excess of storm water.

MR. J. C. QUADE: I have had a little experience with clay in the vicinity of Kankakee. This case is about twelve miles from there. About 15 feet of earth was filled in with yellowish clay on top. The foundation below stands firmly in place. The filling was made of clay last summer after the rains, and for at least 100 feet it simply let loose, came down and spread out. The old grade was solid, the new grade was comparatively solid. It was raised two or three feet with gravel, but as it got wet, both sides parted and one side fell down 12 feet, so straight that you could have dropped a stone straight down. The fill was 17 feet and the fall away was about 12 feet out of the 17 feet. It simply let go and went down without much warning. It cracked and with the gravel work on top the rain water ran over and got into it and softened the whole mass and it would not stay anywhere.

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THE AURORA, ELGIN & CHICAGO THIRD-RAIL ELECTRIC RAILWAY: AND OTHER THIRD-RAIL INTERURBAN RAILWAYS.

BY E. E. R. TRATMAN.

One of the most modern features of the development of the railway transportation system is the development of electric railways as long-distance high-speed lines. These interurban railways form a distinct class of their own, between the steam railway and the city or suburban "street railway," which latter is in these days generally operated by electric power.

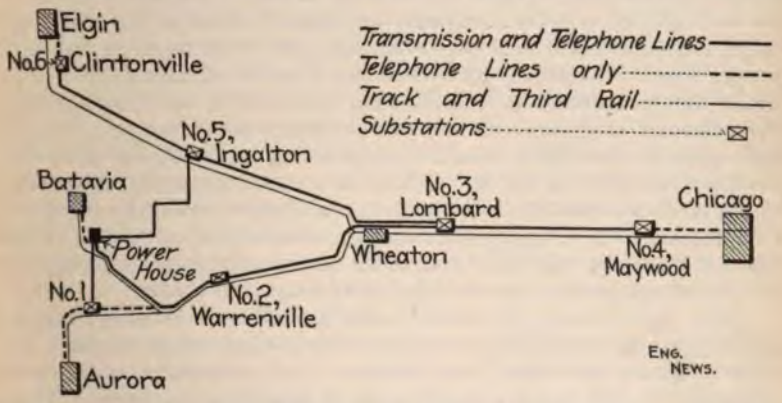
The city of Aurora, in which our Society holds its annual meeting for 1903, has the distinction of being connected with Chicago not only by steam railways, but also by an electric railway of the latest type of what are classed as interurban railways. It is built along its private right-of-way, is double track for nearly half its length, and is operated on the third-rail system instead of on the trolley system. In addition, it is designed for high-speed service, but it is as yet for passenger service only. As railways of this class are becoming so numerous, and are offering almost a new field for engineers, a general description of the road will no doubt be of interest, and the following particulars are compiled in part from personal acquaintance with the road and partly from an article in "Engineering News."

The railway is owned by the Aurora, Elgin & Chicago Ry. Co. of Chicago. The Chief Engineer is Mr. Charles Jones, Mr. E. H. Arnold was Construction Engineer, and Mr. E. Gonzenbach was Electrical Engineer. The headquarters of the engineer and for the operation of the line are at Wheaton, Ill.

The road has about 56 miles of main line, of which 21½ miles are double track. The side tracks bring the total track length up to 80 miles. The distance from Chicago (52d Ave. and Harrison St.) through Wheaton to Aurora is 33.3 miles; the line from Wheaton to Elgin 16.5 Miles; and the Batavia branch, 6 miles. The same interests own the Elgin, Aurora & Southern Traction Co., running north and south and connecting the two western terminals of the other line. This has 70 miles of track, of which 37 miles comprise the interurban line between Carpentersville and Yorkville, while the balance consists of city or street lines in Aurora and Elgin.

The line is operated partly by trains and partly by single cars, the multiple-unit system being adopted, in which each car has its own motive power, but all the motors are controlled from the head of the train. There are trains in both directions every half hour. The run between Aurora and Chicago or Elgin and Chicago is to be made in 45 minutes as soon as everything is in good running order. This will give an average speed of about 45 miles an hour from start to finish, which, with the stops, will necessitate actual running speeds of 50 to 60 miles an hour. The traffic is handled by the telephone train dispatching system, the head dispatcher at Wheaton communicating with the men at the sub-stations, or with the conductors, who report at these stations. The cars are equipped with portable telephones, and means for connecting these with the telephone wires are provided at all turnouts and crossovers; while at intervals along the road the wires are brought down the poles so that the telephones can be attached.

The maximum grade is one of 1.8 per cent. a mile in length, entering the Fox River valley, but on the rest of the system the aim has been to limit all grades to 1 per cent. The ordinary curves connecting long tangents are of 1 and 2 degrees, and the maximum on high speed portions of the line is 4 degrees. Near Chicago, however, there are some very sharp curves, including two reverse curves of 16 degrees, with a short tangent between. The superelevation on curves is about 1 in. per degree, with a maximum elevation of 5 ins.



ENG. NEWS.

The width of roadbed is 16 ft. for single track (13 ft. over toe of ballast), and 28 ft. for double track (26 ft. over ballast). The track is laid with 80-lb. rails of the Am. Soc. C. E. section, 60 ft. in length, and having about 0.6 per cent. of carbon. They are laid with broken joints and spliced with angle bars and four 1-in. bolts. There are 32 oak and cedar ties to a 60-foot rail, and the ballast is of gravel, with a depth of 9 ins. under the ties. The rail joints are fitted with two 12-inch electric bonds to each joint. The rails are cross-bonded at intervals of 500 ft. Split switches are used with 15-foot reinforced switch rails; and No. 10 spring-rail frogs are used for main track turnouts. On double track, the tracks are 13 ft. c. to c., and are connected by crossovers at intervals of three or four miles. On single track there are passing sidings at similar intervals; these sidings are 700 ft. to a mile in length, long sidings being provided at curves so as to provide practically double track, and thus give greater safety for high speed running at some points.

The conductor or third rail is of the 100-lb. Am. Soc. C. E. section, in 33-foot lengths, and is of much softer steel than the track rails, having only about 0.1 per cent. carbon. The object of this is to give greater conductivity, but as the softer steel rusts and corrodes much more quickly than the harder steel, the third rail is painted with a cheap asphalt paint, thinned with gasoline. This rail is carried by insulating supports on the ties (every fifth tie being of extra length). At road grade crossings the third rail is cut; the last rail is dropped 2 ins. in its length and has its end fitted with an incline 24 ins. long to raise the contact shoes of the cars into place. The ends of the rails are connected by cables laid under the crossings. Single cars will drift over the crossings, but trains (and even single cars at short crossings) will have the front shoe again in contact before the rear shoe has left the rail. As all the car lamps go out when the car is going over a road crossing, experiments are to be tried with an overhead wire at the crossing and a transverse wire low above the roof of the car. There is no room for storage batteries or gas tanks on the cars. At switches and crossovers, the third rail is depressed so as to clear the shoes of cars on the turnout. If this was not done the rail would have to be cut, and cable connections used, as at road crossings, which would be inconvenient.

The right-of-way is fenced with woven wire fencing, and all highway grade crossings are fitted with cattle-guards of vitrified clay blocks. There are only four railway grade crossings with steam railways, three of which are protected by interlocking plants. There are also three crossings of street railways.

All steel bridges were designed in accordance with Cooper's specifications, with his Class E-40 loading. There is only one truss bridge, crossing the Chicago & Northwestern Ry. at Elgin, on a skew. This has a span of 158 ft. 7 ins., with shallow floor construction, and one end rests on columns, connecting with a steel viaduct 363 ft. long. All the other steel bridges are of plate girder construction. Besides these there are a number of small openings spanned by I-beams with concrete filling. The steel bridges have open floors, but with closely spaced ties and a substantial floor system. All piers and abutments are of concrete.

There are four concrete bridges, besides a number of concrete culverts and cattle-passes. The Salt Creek bridge has two 35-foot arches (with a rise of 1 in 6); the Poplar Creek bridge at Elgin has one 30-foot arch, and another bridge over the west branch of the Du Page River, and on the Elgin branch, has two 30-foot arches (with a rise of 1 in 10). The smaller structures have arches of 10, 12 and 15-foot span, and one of these has two 15-foot spans. Old 60-lb. rails are laid in all the arches, except those of 12 and 15-foot span. They are placed about 36 ins. apart, near the center line of the arch ring, and extend into the haunches.

In one cattle-pass, concrete jack arches are turned between the I-beams, but instead of the ordinary removable wooden centering, arches of wire netting were fitted on the lower flanges and the concrete placed on these, being filled in from both sides towards the crown. The end of each I-beam rests on a vertical 60-lb. rail embedded in the abutment, and a diagonal rail is embedded in each wing wall. This arrangement enables lighter walls to be used, with an economy in concrete and a saving of about 30 per cent. in cost as compared with a structure having concrete abutments and an open I-beam floor.

The Chicago terminal is a transfer station for connection with the Garfield Park line of the Metropolitan West Side Elevated Ry. The cars run between two platforms, on the outer sides of which is the terminal loop of the elevated railway, which is reached by an incline from the elevated station at 48th St. At Elgin and Batavia the line runs on its own right-of-way up the river bank to a terminal station in the center of the town. At Aurora the cars run for about half a mile along the street. There are about 30 stopping places in all, most of these having simply open platforms at road crossings. Each of the six brick sub-station buildings has a waiting room and platform for passengers, and there are a few small frame stations. The main repair shops and car sheds are at Wheaton, and are of fireproof construction throughout.

The cars are 47 ft. 3 ins. long over all, 8 ft. 8 ins. wide, and weigh 74,000 lbs. empty. They have steel underframes stiffened by truss rods, and steel framed trucks. The wheels are 36 ins. diameter, and the axles 6½ ins. diameter, with journals 5x9 ins. Contact shoes are fitted on both sides of each truck, and there are two trolley poles on the roof for use on the short piece of street line in Aurora. The cars have transverse seats, upholstered in rattan, and have seating accommodation for 56 passengers. They are equipped with telephones, Christensen air brakes, electric heaters and electric interior lights and headlights. At one end is a smoking room. The platforms are vestibuled and have side and end doors in the vestibule, the latter allowing for access between the cars when coupled up in trains. The dimensions of the cars correspond very closely with those of the cars on the Chicago elevated railways, and the trucks are so arranged as to enable the cars to readily pass the 90-ft. curves on these lines. This is in view of the possibility of eventually running the cars over the elevated railways into the city. Each car has four motors of 125 H.P., the gear ratio being 1.61 to 1.

The power house is at Batavia, Ill., and this also supplies current for the line from Elgin to Aurora, and for the street cars in these cities. The city service tends to equalize the load on the power station and prevent the high peaks which occur when only interurban traffic is operated. The power house is 202x160 ft., of steel frame construction, with walls of limestone and common pale brick, and a roof of tar and gravel composition on plank sheathing.

There are three Corliss cross-compound condensing engines of 2,200 H.P., running at 75 revolutions; cylinders 32x60 and 64x60 inches. On the middle of the shaft of each engine is a revolving-field generator of 1,500 kilowatts, and a 20-ft. 80-ton flywheel. Space is provided for a fourth engine and generator. There are also two horizontal engines of 200 H.P., each directly connected to an exciter of 160 K.W. Steam is supplied by Edge Moor water-tube boilers of 500 H.P., carrying 180 pounds of pressure.

The plant also includes Green economizers and Worthington condensers and pumps, the main circulating and feed pumps being driven by induction motors. The power station is close to the Fox River, and the water supply for the boilers and condensers is taken from the river by a conduit which passes through the building, while the waste water is discharged into a culvert which leads back to the river. The 240-foot chimney, of brick and stone, is placed at the middle of the building, and the top of its 11-foot flue is 225 ft. above the grates. Coal is delivered to a storage bin of 2,000 tons capacity, with hoppers in the bottom, from which the coal falls by gravity through gates into steel cars of 1 ton capacity, running on a track of 24½ inches gauge, the wheels having outside flanges. From under the hopper the loaded car is run to an elevator, the floor of which is a turntable, revolving on steel balls and fitted with an automatic weighing apparatus. This elevator raises the car to a track running along over the hoppers feeding the magazines of the automatic stokers, into any of which the coal can be dumped as required. Similar cars run on a track passing under the ash pits and provide for the removal of the ashes.

The transformers are on the engine room floor, and are cooled by a current of air passing up through them.

The power plant generates an alternating current of 26,000 volts, which is sent out over the high-tension cables to the sub-stations. Stationary transformers reduce this to a 420-volt alternating current; this enters the rotary converters, which deliver a 600-volt direct-current to the third rail. In the arrangement of the high-tension circuit, provision is made for alternative circuits in case of failure in emergency. Each circuit consists of three aluminum cables, arranged in a triangle, 20 ins. c. to c. These are transposed at intervals of a mile. The poles carrying the high-tension cables are 40 ft. long and 80 ft. apart, and the telephone wires are carried on the same poles, below the cables.

There are six sub-stations, approximately 10 miles apart, feeding the third rail for five miles in each direction. All these are fireproof buildings of brick and stone, with Monier concrete steel floors; and they have waiting rooms and platforms to serve also as passenger stations. Each sub-station has six stationary air-cooled transformers, two rotary transformers, and a fan with induction motor for supplying the air blast to the transformers.

The third rail between any two sub-stations constitutes a continuous section fed by the sub-stations at each end. On the line, all the third-rail sections on the entire system are connected together through the medium of the sub-station bus-bars and feeder panels, so that there is opportunity for the sub-stations to divide the load among each other as far as the conductivity of the third rail will permit, and in case of an excessive load upon one section the sub-station nearest is not required to carry the whole load. On the double-track part of the road the third rails on the two parallel tracks are not connected together, but form two separate sections through the medium of the sub-station feeder panels and bus-bars, just as are any other sections, but it is proposed to tie the two third rails together through a circuit-breaker located half way between the sub-stations, so that there will be the benefit of the two conductors in case of a blockade on one track. The use of a circuit-breaker would be necessary to avoid trouble on both third rails, as would happen in event of a short-circuit on one.

The road is laid out for six sub-stations. The transmission is by 26,000-volt, three-phase alternating current. The high-tension lines are carried on cross-arms, with insulators 30 inches between centers on the cross-arms, and the cross-arms are 24 inches apart. The telephone lines are on cross-arms 7 ft. below the lower transmission cross-arms. There are two telephone circuits, one for general business and the other for dispatching. The telephone lines are transposed every fourth pole and the high-tension lines every mile. The telephone wires are transposed by tying both to a single wide petticoat transposition insulator every fourth pole.

The erection of 650 30-foot, 4,250 40-foot, and 150 50-foot poles was not an easy task. The greater part of the poles were hauled from the nearest railway stations by wagons, and as the right-of-way was minus bridges and only partially graded, three or four 40-foot poles made a big load for one team.

The holes for 40-foot poles were put down 6 ft., and many were blasted with dynamite, a two-inch hole being bored six feet deep and a stick of 40 per cent. dynamite tamped in the bottom. Then the hole would be half filled and another stick put on top of this and tamped, both being set off with a magneto generator. This made the hole the same diameter all the way up, and as the sod is cut the size of the hole intended, there was no tearing up of the ground.

No direct-current overhead feeders are needed, as the third rail has sufficient capacity to conduct all the current from the sub-stations to the trains. The overhead pole line has only to carry two telephone circuits, and the 26,000-volt, three-phase, high-tension feeders which supply the sub-stations. The high-tension feeders are of standard aluminum cable. Poles carrying these lines are 40 feet long, placed 80 feet apart.

The system of high-tension distribution is arranged to secure freedom from interruptions of service due to short-circuits or breakages on any one transmission line. Three high-tension feeder lines leave the power house at Batavia. A line runs directly across the country to sub-station No. 1, near Aurora. Another high-tension pole line follows the railway, supplying sub-stations Nos. 2 and 3, and extending to Maywood. The third line from the power house is built directly across the country to sub-station No. 5 on the Elgin branch, and along the right-of-way from this sub-station to Wheaton, at which point it joins the pole line from the Aurora branch, and the two three-phase circuits run on the same poles to sub-station No. 3, with one circuit from there to No. 4. Sub-station No. 6 is supplied by a line running from sub-station No. 5.

The regular sub-station equipment for all the sub-stations comprises two 1,500-kilowatt rotary converters with a bank of three transformes each. The sub-stations have air-tight bus-wire compartments, in which air is kept under pressure by the blower for cooling the transformer and the reactive coils. The top of the coil and transformer cases have openings by which the amount of air passing may be regulated.

At the Warrenville, Lombard and Ingalton sub-stations there is another panel devoted to the out-going line to the next station. The principal object of this is to make it possible to cut off the line beyond in case of short-circuit or line trouble. After passing the lightning arresters, the incoming line goes through the current transformers which supply current for an indicating ammeter, and the current coil of a reversal relay. This reversal relay is the same as that on the power house generator panels, and will act to open the oil switch on the incoming feeder in case the sub-station attempts to give current to line instead of receiving it.

After passing the current transformers the incoming line is taken to the three-pole motor-operated oil switch. The switch is also controlled by a hand switch on the feeder panel. From the oil switch the incoming feeder goes directly to the bus-bars. The panel for the outgoing line and controlling apparatus connected therewith are similar to the incoming, except that the motor-operated oil switch is controlled by an overload relay instead of a reversal relay, and there is an ammeter in each leg of the circuit. The potential transformer for the reversal relay on the incoming panel is connected directly to the alternating-current bus-bars. Current for the operation of the motor-operated switches is supplied by a small storage battery located in the cabinet in the sub-station.

Each rotary converter has its bank of three transformers controlled by a motor-operated oil switch. The alternating-current panel is to all intents and purposes a high-tension panel, although there are no high-tension wires upon it. After passing the main switch the high-tension lines go through current transformers for the switchboard instruments. The converter panel contains a power-factor meter, ammeter, voltmeter, overload relay and controlling switch. The machines may be started on direct-current from the third rail or by alternating-current, and can be started alternating-current from rest and put into service in 30 seconds. When starting on alternating-current the three-pole, double-throw switch located on top of the reactive coil is first thrown up, giving only half voltage until considerable speed has been attained, when this switch is thrown down and the rotary given full alternating-current pressure through the reactive coil.

THIRD-RAIL ELECTRIC RAILWAYS.

The third rail conductor was invented in the very early days of electric railways, but it was first used in practical service in 1903, on the Intramural Elevated Railway at the Columbian Exhibition in Chicago. It was next adopted for the new Metropolitan electric elevated railway of Chicago, in order to avoid the unsightly appearance of poles and wires on the elevated structure. It is now used on elevated roads in various cities and also on underground lines. Its first application to practical surface work was on the Nantasket Beach branch of the New York, New Haven & Hartford Ry., and this road afterwards used it on some local lines. The third rail is about 20 to 27 inches from the track rail, and its head is usually 6 inches above that of the latter. It is supported by an insulator on every fourth or fifth tie, these ties being made of extra length. The value of an ordinary steel rail as a conductor, as compared with copper, is about 10 to 1 or 12 to 1, with the additional disadvantage of frequent joints and bonds in the rail. But with second-class rails at $20 per ton and copper at $360 per ton, an ample amount of steel can be provided and still leave a considerable saving. On one new English electric railway, the third rail conductor is used, and there is a fourth rail to carry the current back to the power house, instead of using the track rails for the return circuit. The third-rail system cannot, of course, be used for lines built on the public roads.

There are as yet very few third rail interurban railways, the overhead trolley wire system being more generally used. Besides the Aurora and Chicago line, there is a line at Muskegon, Mich.; another between Wilkesbarre and Scranton, Pa., and another from Albany to Hudson, N. Y.; while the New York, New Haven & Hartford R. R. has this system on some local lines.

The Grand Rapids, Grand Haven & Muskegon Railway is 35 miles long, laid out to avoid grade crossings, all railways being crossed by steel bridges with earthwork approaches of easy grade.

The track is laid with 70-pound rails. The third-rail system is used, except that short sections of overhead wires (not more than 2,500 feet in all) are used through towns and cities. The third rail weighs 65 pounds per yard. The power house has four boilers of 250 H.P. each and six Westinghouse generators directly connected to vertical engines. Two of these generate direct-current at 650 volts. The others generate alternating-current at 390 volts, which is transformed to 16,600 volts for transmission to the two sub-stations at Coopersville and Walker. These are 12 and 27 miles from the power station at Fruitport. The district near the power house is supplied direct from two 650-volt direct-current generators at that house. The sub-station rotary converters supply the other parts of the line. The passenger cars are 52 feet long, and each has two motors of 150 H.P. There are also 40-foot express cars. The service is controlled by telephone from Fruitport, and the cars are run every half hour, making an average speed of 35 miles per hour, including stops.

The Lackawanna & Wyoming Valley Ry. runs from Wilkesbarre to Pittston and Scranton, Pa., 20 miles, and is being extended to Carbondale, making 36 miles in all. The line is substantially built, with maximum grades of 2 per cent., and maximum curves of 4 degrees, except one of 12 degrees near a station. The line is double track, laid with 75-lb. and 90-lb. rails, and having a 75-lb. third rail conductor. The main power plant has two Westinghouse 2,000 H.P. engines directly connected to two double current generators. These supply direct-current at 650 volts, which is delivered to the third rail, and alternating-current of 390 volts. This latter is stepped up to 22,000 volts for transmission to the sub-station, where it is stepped down and converted into direct-current at 650 volts. The equipment includes passenger cars, freight cars and combination passenger and baggage cars, all about 52 ft. long. The front truck has 33-in. wheels and no motors, while the rear truck has two motors of 150 H.P. each. The fast trains average 40 miles an hour.

The following discussion of the third-rail and trolley-wire systems for interurban electric railways is taken from "Engineering News:"

THE THIRD-RAIL AND TROLLEY-WIRE SYSTEMS FOR INTERURBAN ELECTRIC RAILWAYS.

In the development of the long-distance and high-speed electric railways, which are becoming such an important feature in local transportation, there has as yet been but a limited adoption of the third-rail system of current conductor. Partly on account of the fact that these railways are a development of the street electric railway, the natural tendency has been to continue the use of the overhead trolley wire. But besides this there are certain objections to the third-rail system, in which the "live" rail is readily accessible, and is therefore more dangerous than the overhead wire. The third-rail system is used only on lines having their own right of way, which is closely fenced in, and the rail is broken at level crossings, connection being made by an underground cable. Yet fences and cattleguards are not sure preventatives against trespassing, especially on the part of curious or mischievous persons, and it remains to be seen how much serious danger there is in the use of the third rail.

One of the reasons given for the use of this system is that the trolley-wire system is not so well adapted for high-speed service, but as a matter of fact many high-speed trolley lines are in operation and experience little trouble from the trolley leaving the wire; in fact, probably no more trouble than is experienced on city lines. On the lines of the United Traction Co. of Indiana (154 miles) the trolley system is used exclusively, and the cars are run at schedule speeds of 40 to 45 miles an hour, while speeds of 50 to 60 miles an hour are not infrequently attained. Yet the trolley very rarely leaves the wire. On the other hand, the third-rail system is considered as a general improvement upon the trolley-wire system for railways of this class, and the cost of maintenance will probably be very much less than for the overhead construction required to support the trolley wire, especially where there are numerous curves, switches, etc., which require a more or less complicated overhead special construction.

The Albany & Hudson Railway & Power Co. operates a line between Albany and Hudson, N. Y., a distance of 38 miles. Through the cities the trolley system is used, but outside of the cities (where the line is laid on a private right of way) the third-rail system is used. The business resembles that of a steam railway, and all classes of steam railway cars are hauled over the line. The reason for the adoption of the third-rail system in this case was the very crooked condition of the line, and it was feared that a high speed could not be maintained with an overhead trolley wire. The traffic is also very heavy at times, and the third rail is said to have proved a much better conductor than the trolley. A current of 550 volts is carried in the third rail.

The cars are operated at an ordinary speed of about 25 miles per hour, but a speed of 60 miles an hour is often attained, and even a higher rate of speed than this is occasionally made on straight and level track. The line is fenced with a woven-wire fence the entire distance. At highway crossings, cattleguards are placed to prevent animals and persons from getting on the right of way; and a sign is also placed on each side of the highway, reading, "This railroad is operated by an electric rail; walking upon the track or other trespassing is forbidden." At all farm crossings, cattleguards are used to prevent stock from getting upon the right of way when being driven across the tracks at such points.

Since the road began operations, two persons have met their death by coming in contact with the third rail. The first case was that of an old man, who was in very feeble health, and it was shown that he had fallen down several times during the day on the streets of Albany and that he was not in a physical condition to withstand any shock. It is considered an open question whether he met his death by coming in contact with the third rail or whether he had fallen in a fit and was found dead on the rail. The next case was that of one of the car conductors, a man about 60 years of age, who was out in a thunder shower, his clothing being thoroughly soaked. While performing his work he slipped and fell backwards, striking the back of his head on the third rail, his body lying across the main track rail. In this case it was a question if the blow on the back of his head did not have more to do with his death than the shock from the third rail. A few animals have been killed by coming in contact with the third rail. This record would seem to show that the third-rail system is not so dangerous as is sometimes supposed.

At first there was a little trouble from boys and others tampering with the third rail, by short circuiting it with short pieces of wire and other pieces of metal. This trouble was very slight. On one occasion the third rail was short-circuited by some mischievous person placing a splice bar from the third [illegible] caused a temporary shut-down of about 30 minutes [illegible] there has been no trouble from this source.

The most recent [illegible] of the third-rail system is the line of the [illegible] Elgin & Chicago Electric Ry. (about 50 miles); and on this road the third rail [illegible] along the route. It has its own right of way [illegible] streets and roads at grade, and there [illegible] liability of accident, especially [illegible] service. The third-rail system [illegible] New York, New Haven & Hartford R. R. On the [illegible] of Chicago and New York the same system is used, and [illegible] the lines, but of course these tracks are [illegible].

[illegible] the use of the third-rail system on the electric [illegible] of the New York, New Haven & Hartford R. R., and information [illegible] of this system has been obtained from Mr. N. H. Heft, [illegible] Electrical Department of that road.

The company [illegible] with the third-rail system through a desire [illegible] the simplest and least expensive method of transmitting power. The cost of installing the third-rail system was found to be very much less than the overhead system, and the comparative cost of maintaining the third-rail and overhead systems has been found to be very much in favor of the former. Practically the only item of expense in connection with the maintenance of the third-rail system is the renewal of underground cables at crossings. From experience gained with the present installation, Mr. Heft hopes to be able to place cables under the crossings in such a manner that there will be practically no deterioration. When this has been accomplished, the only expense will be an occasional tightening of the bolts at the joints of the rails, which will amount to very little.

The third-rail system is in use between Hartford and Bristol (18 miles), and between Berlin and New Britain (3 miles) in Connecticut; and between Braintree and Cohasset, in Massachusetts (11.5 miles). The average speed maintained in operation under the regular schedule is about 35 miles per hour. The right of way is fenced, and at grade crossings the ordinary surface cattleguards are in use. The voltage carried by the third rail is from 550 to 650 volts.

One of the great obstacles that has been encountered in introducing this system, which presents so many advantages, is the fear of liability of persons being killed or injured by coming in contact with the third rail, and also the fear of trouble caused by persons tampering with the rail. The experience on the Albany & Hudson Ry., above referred to, and on the New York, New Haven & Hartford R. R., appears to indicate that the danger of the third rail has been exaggerated, and that the objections to it on this score have not been well-founded. The right of way should, of course, be fenced in, and provided with cattleguards at road crossings; then if people persist in trespassing they must be held responsible if they receive injury. As to the matter of tampering with the rail and short circuiting the current, the strength of the current will usually soon burn out and destroy any small connection such as a wire, and if the railway companies take prompt action and have the offenders arrested, the publicity and punishment will soon have a deterrent effect upon mischievous persons. This course of action has been taken by the Aurora, Elgin & Chicago Ry., whose line was recently opened, and several boys have already got into trouble. Probably in a few months the railway will be so familiar that it will not suggest itself as an outlet for mischievous tendencies, and will not be tampered with any more than the steam railways. In regard to the experience in these directions on the New York, New Haven & Hartford R. R., we give Mr. Heft's statement in his own words, as follows:

"We have had very few accidents due to the location of the current conductor. A few persons have come in contact with the rail, and have received slight burns. Two persons have been found dead on the track, but in both cases there has been reasonable doubt as to the cause of death. One (a man) was subject to epileptic fits, and was known to have been under the influence of liquor the night before he was found. The other (a boy) was also known to be subjects to fits, and it is thought he may have been taken with one while walking along the track, and that, while in an unconscious condition, he remained in contact with the third and service rails a sufficient length of time to be killed. With these exceptions, we have had practically no serious accidents on account of the location of the third rail.

"A few dogs and one horse have been killed by coming in contact with the third rail. The horse was running away and took to our roadway at a grade crossing. We have also had several dogs so seriously shocked while loitering about our tracks, that they have thereafter religiously avoided the vicinity of the railway in general, and the third-rail track in particular.

"We have experienced trouble on our Hartford & Bristol line from boys and mischievous persons causing short circuits by throwing metallic substances across the third and service rails. We have succeeded in bringing one or two such persons into court, and the result has been that we now have practically no trouble from this source."

GROWTH OF ENGINEERING EDUCATION.

BY A. N. TALBOT.

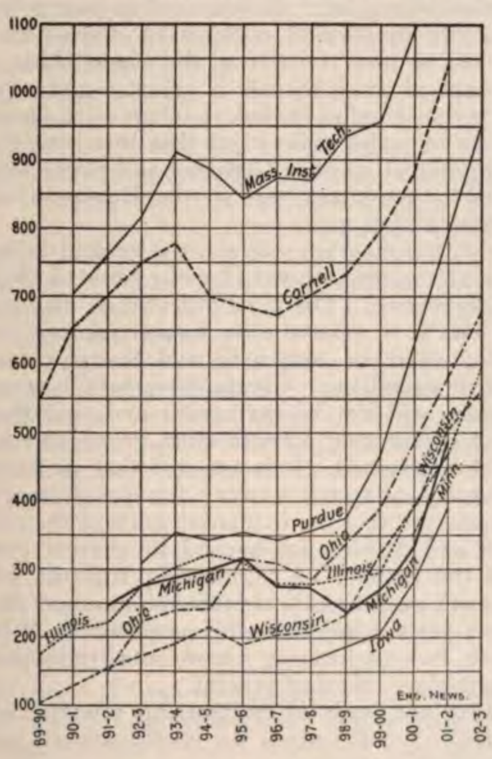
With the recent awakening to our industrial progress and the opportunities for future industrial activity in this country has also come a better understanding of the growth of industrial education and of its effect upon the material prosperity of the country. As an example of this growth the great increase in numbers of students in attendance at engineering schools may be cited, and a short discussion of this growth and what it means may not be out of place.

The industrial growth has brought with it a great demand for men to take charge of industrial operations, manufacturing establishments, railways, public works and other enterprises. At first few technically trained men were utilized, but in recent years the demand for such men has greatly increased. In fact the growth of technical education has not only been greatly stimulated by the industrial expansion of the country, but has also reacted to give a powerful impetus to this industrial activity. The same effect has been seen in other countries. Germany is a notable example of the effect of technical education during the time of the growth along manufacturing and industrial lines, and Germany concedes a great share to the usefulness of the men trained in her technical schools.

The growth in numbers of engineering students is illustrated by the diagram which shows the attendance in the engineering colleges of some of the western state universities and at two prominent eastern institutions. The report of the Committee on Statistics of the Society for the Promotion of Engineering Education gives a total of 16,600 students in attendance in '01-'02 in 115 institutions in this country, the majority being enrolled in about 30 institutions. The number given in '98-'99 was 9,600 and in '88-'89, 3,000. This increase of 500 per cent. in twelve years is remarkable.

With this increase in numbers has come a great modification in the courses of study. Where formerly many of these schools gave the mathematical principles and a few general applications to engineering practice, filling up the remainder of the four years with general subjects, the courses now are well considered and arranged with a view of giving both a good foundation in the fundamentals of engineering and some knowledge of details in a particular line of engineering. While the pendulum is now swinging back from the tendency to excessive specialization and the effort to give a large amount of professional knowledge, the consensus of opinion of the best educators seems to be that engineering schools must not only give the fundamental or foundation subjects in a substantial way, but there must be some application of principles to design and construction and sufficient laboratory experimental work to give the student a better conception of the meaning of his principles and to start him in the way of getting at the details of professional work.

Requirements for the educational plant have also greatly changed. Formerly a bench, a few machine tools, an indicator, a transit and level, a testing machine and a few other pieces of apparatus were considered adequate. Now a great variety of apparatus for the different lines of engineering work and of engineering education is required, and it is expected that the institutions will also be able to carry on investigational work in given lines. Cornell University has engineering equipment, not including buildings, costing over $500,000; Massachusetts Institute of Technology has as much; Columbia University, the University of California and other universities are putting large amounts of money into their engineering laboratories and equipment. Part of this expenditure is for duplication of plant to accommodate a larger number of students, and a



large part is for the purpose of illustrating and making investigations along the greatly increased number of lines of work now open.

In many respects American engineering schools are in advance of European institutions. The well known technical schools of Germany and Switzerland are of high grade, but so far as I have been able to learn their instruction to undergraduate students is not as good as that given in the best American technical schools. The drill in mathematical subjects may be good, but the work done in other directions is incomplete. For example, in the well known Prussian school at Charlottenburg, near Berlin, cited as one of the most complete in Europe, the mechanical engineering student scarcely has an opportunity to use an indicator during the whole of his course. The general equipment of these schools is valuable and represents very large expenditures. English technical schools are known to be far behind ours. It must be understood that this statement does not apply to investigational work in Germany and Switzerland, which is done by special investigators, nor to the European trade schools which have attained high rank.

Reference to the diagram will show a marked falling off in attendance at our engineering schools after the panic of 1893 and during the industrial depression. The same observation may be made upon attendance at schools in general after former panics. It may be expected then that when the next industrial change comes there will be a falling off in attendance. Careful observers, however, conclude that this decrease will not be permanent and that the number of students in our engineering schools must go on increasing until a very large total is obtained. It is asserted that we have not nearly reached the number of men necessary for our present average industrial condition, and that the industrial work of the country is certain to expand and develop far beyond its present conditions. A comparison of the number of engineering students with those in other lines of work goes to indicate that the numbers in engineering schools have not yet reached their full proportion. It seems proper to conclude, then, that engineering schools must in the future provide for a greater attendance than at present.

In discussing the needs of engineering schools two topics are worth considering: (1) the needs for investigational purposes; (2) those for educational purposes.

1. It is believed that the advantage of engineering schools to our industrial enterprises is not yet fully appreciated. Germany concedes that a large factor in its industrial expansion was the knowledge and experience gained through investigations made in the technical schools. The recent great gains made in agricultural science through the activity of the State Agricultural Experiment Stations is well known, and it is estimated that the farmers have profited many times over by the expenditures thus made. The last state appropriation in Illinois of $54,000 per annum for experimental

work in horticulture, animal husbandry, soil conditions, crop culture, etc., resulted in the establishment of knowledge of great value to agricultural operations. In the same way it is believed that engineering schools may be of great service to the industrial resources.

2. The educational needs are even more apparent. Increased numbers require increased facilities, and the development of engineering education makes it necessary to have a modern and well arranged equipment. It is not necessary here to enumerate such equipment, but the needs are great for each of the different courses included in a college of engineering. The possession of adequate equipment will not take the place of superior class instruction, but it will greatly aid such instruction.

The engineering schools of the United States are doing a large work. Their place in the development of the nation's resources and in the training of her citizens will be even higher. These institutions deserve encouragement and support. In the west, efforts are being made to increase equipment and facilities, and it is to be hoped that our western schools may be enabled to maintain the high place they have held in educational and engineering circles.

In reference to the accompanying diagram, you will notice a marked and steady growth of these schools in the last five years, and they are increasing at a rapid rate.

In this connection it may be proper to state that there is a movement on foot in Illinois, asking the Legislature for a largely increased appropriation for the College of Engineering. It is believed that the time is ripe for having that increase, and that the institution has done work which will show that it will be able to return to the state in services, many times the amount of the expenditure.

DISCUSSION.

MR. J. W. ALVORD: I would like to ask how the present attendance or number of students at the colleges compares with the number 25 years ago, in this country.

PROF. TALBOT: I have no statistics for 25 years. The attendance given for 15 years ago was 3,000. While there are now 115 institutions, I suppose that 25 years ago there were not more than 10. One reason for the large growth in numbers is the fact that many of these are supported or aided by the Hatch bill, which gives a certain amount of money in each state or territory, part of which is to be used for engineering education.

CONCRETE FOR BUILDINGS AND FARM WORK.

DISCUSSION.

MR. L. Z. JONES: I would like to call the attention of the Engineering College of the University of Illinois to the need of some way to present the usefulness of concrete in construction on the farm, which is a place where it is going to be greatly used. When we mention concrete, we think of pavements, sidewalks, or foundations, etc. It has been the universal custom to build everything on the farm of wood, except the cellar walls, and they are braced up with wood in many instances, and would fall down if the house did not hold them down in place. I was invited to come down to Champaign next week to tell the assembly of young farmers down there about concrete on the farm. It should be presented right away to the people who can use it in the place of wood, as wood is becoming so scarce.

At the Farmers' Institute at Woodhull I showed them they could build a great amount of work of concrete with less money than wood. For instance, a feeding floor can be built of concrete for two-thirds of what it would cost to build it with planks. The institution at Champaign is the place to begin this practical information, and it would be a good thing for our farmers.

MR. B. J. ASHLEY: It might be interesting to know the result of a little computation I made last week in the use of concrete blocks as building material for walls for residences or factories. I took the prices of cement to be $2.00; labor, $1.50 a day, and the gravel at $1.00 per cubic yard, being about the correct Chicago prices at this time. Estimating the cost of a wall 7 feet high by 100 feet in length, the result was as follows:

Common 16-inch Rubble Wall, 9.3 cords at $19.00		$176.70
Common 12-inch Brick Wall, 14,700 brick at $12.00		176.40
Pressed Brick Wall:		
4,900 pressed brick in 12-inch wall at $38	$186.20	
9,800 common brick in 12-inch wall at $12	117.60	
		303.80
Bedford Stone Wall:		
700 sq. ft. Bedford (Ind.) stone at 75c	$525.00	
9,800 common brick backers at $12	117.60	
		642.60
Palmer Hollow Concrete Building Blocks, 30x10x9 inches:		
375 Palmer Blocks, laid in wall, 65c each		243.75

These blocks cannot be distinguished from stone, except upon close inspection.

MAINTENANCE OF EARTH ROADS.

BY IRA O. BAKER.

In the last 10 or 12 years, a large amount of literature has been set afloat in newspapers, magazines, and reports upon the subject of road improvement. But comparatively few people believe in the views as commonly presented, and those who would be expected to know most about roads and also those who use them most, are the least ready to assent to these views. To explain this I will briefly call attention to some facts concerning the source and purpose of much of the current literature on good roads. About ten or twelve years ago, some well organized manufacturing interests wishing to increase the sale of their goods started an agitation for better roads, and unfortunately committed the conduct of the scheme to those who knew little or nothing about either road construction or the larger principles of economics and political action involved in any comprehensive system of road improvement. By these interests and their followers an attempt was made to carry into effect a reform of the whole system of constructing and maintaining the roads of the nation. Many politicians and newspapers sought to secure public favor by endorsing the proposed revolution, and, as a consequence, wide circulation has been given to certain facts and theories which, in their proper field, were true, but which when presented without limitation were false and misleading.

These intemperate advocates of road reform have frequently cited the wagon roads of England, France and Switzerland as examples of what the United States could and should do, regardless of the fact that those countries are abundantly supplied with good road-building materials, while in this country there are areas greater than the combined area of those countries in which there is absolutely no suitable road-building material. Again, the stone wagon-roads in those countries were built under the stimulus of military necessity and commercial need before the advent of the steam railway, while in the greater part of this country the railways have been the pioneers, and now there is no commercial need of long lines of wagon transportation, except perhaps in the immediate vicinity of the large cities. The density of population, the industrial occupation, and the agricultural methods are all very different in those countries from those prevailing in this.

The method employed in maintaining wagon roads in those countries, with their dense and poorly-paid population, is no criterion by which to judge of what is wise or possible in this country. The political and social ideals on the two sides of the Atlantic are also that the truth becomes falsehood. This ill-advised and intemperate road agitation has in many cases done harm, since a form of road construction has been advocated that under most conditions has been entirely impracticable. The result has been that those who are most interested in good roads have been most concerned to prevent road construction and maintenance being made subservient to interests foreign to those who chiefly use the roads and also pay for them. As a result of this condition of affairs, the improvement of local roads has not in itself received the attention that its importance warrants, and it is probable that road improvement has not kept pace the past ten years with the industrial development in other lines.

It is freely admitted that the roads in central Illinois have been very greatly improved in the last 25 years, but they can be improved further without material expense by attention to a few minor details. Before attempting to show how this can be done, permit me to explain how it cannot be accomplished.

In the first place, it is probable that no important and lasting improvement in road matters can be secured by legal enactment, either State, county, or township, except where the laws are supported by an intelligent and active public sentiment. Numerous examples could be cited where the higher legislative powers have passed laws to be enforced by the local authorities which have rested in entire desuetude. The dominating spirit of our system of government is home rule, in road matters as well as in many other things, and the local community is not likely to relinquish the rights it has long exercised.

In the second place I do not believe that the roads would be better cared for if the work was done by men who gave all their time to it. This plan has some promising advantages, and is probably a necessity for the maintenance of first-class broken-stone roads, having any considerable amount of travel; but it is impracticable for truly rural roads, whether of broken stone or earth. The amount of labor required is so small that the care-taker would have so great a length under his charge that he could visit each section only at comparatively long intervals, and, therefore, could not become intimately acquainted with the road and could not do the work at the most favorable time.

In the third place, I do not believe that the roads would, on the whole, be any better, if road taxes were paid in cash instead of in labor. It is unquestionably true that often a farmer does not work with as much energy when paying his labor road-tax as when working in his own field. But it is equally true that no man works for the public with as much energy as for himself. It is not proved that changing from the labor-tax to the cash-tax system would not be going from bad to worse. Notice first that the disease is not as serious as charged, many farmers giving even more labor than is exacted. Again, road taxes are in effect assessed by farmers, and paid by farmers; and farmers would probably rather pay two dollars in labor than one in cash. Further, the officials who permit inefficiency under the labor-tax system, will probably permit equal inefficiency under the cash-tax system.

City streets are maintained on the cash-tax system. Are they better or more economically cared for than country roads? The writer has had a wide opportunity to compare the conditions in six or eight counties of Illinois, and also in other States, and his observation is that the streets of the villages and small cities are not as well cared for as the roads in the surrounding country. The writer is of the opinion that, as a rule, the streets of even the large cities are not as well nor as economically cared for as the rural highways. There would be some justice in arguing that this condition was proof that the cash-tax system was not as efficient as the labor-tax; but the writer does not so regard it, since there are more important conditions that control in the management of both city streets and country roads. The difference between the labor and the cash tax has but little to do with the condition or cost of the roads. The writer has repeatedly seen excellent roads under each system, and immediately adjoining has seen very poor ones under both systems.

The chief defect in the construction and maintenance of American highways is the lack of intelligent and effective supervision. We shall never have good construction until there is worked out for each locality a proper system of rules, either traditional or printed, for the care and improvement of the public highways; and we shall never secure good maintenance until the public generally comes to believe in the value of better roads.

The thing now is for the people directly interested to see what can be done to work out the road problem in each community. As before stated, I believe that the roads can be materially improved without much, if any, expense.

This country has come to its present position of supremacy in industrial affairs chiefly through competition in design and division of labor. These principles should be introduced into the care of our earth roads, giving competition in design and individual responsibility in the care of our roads.

To secure this, divide the roads up and allot definite sections to farmers and publish these allotments. As far as possible, require each man to care for the road nearest home and which he travels most. He should, of course, be instructed properly, and his work would be subject to proper supervision. One man will probably care for his section in one way and another man in some other way, but if they are subject to some supervision which will prevent bad or foolish methods, this will bring into play competition of design and finally there will be evolved the best way of doing the work. It is entirely feasible to have annual competitions with inspections and the award of prizes and diplomas. Railways find annual inspections and nominal cash prizes exceedingly effective in the improvement of track maintenance work, which work is under the supervision of trained engineers.

It would be well to depend less upon the ordinary road machine for the care of the roads. I have seen many examples of the effective use of a railway rail or a wooden scraper in leveling the roads. Either of these devices is cheaper, lighter and more easily handled than the four-wheeled grader, but to be effective it must be used earlier in the spring. You can go over the road several times with a rail or a harrow as cheaply as once with the grader. These tools can be used much earlier than the grader, and thus hasten the coming of good, smooth roads. For several years I have noticed that the roads of Bement Township are unusually good, particularly early in the spring, and this, notwithstanding, they have a very sticky soil. This is due to the frequent use of the rail scraper just as the frost is going out. One round in the middle of the road is all that is needed, and two teams walk right along so that the work is not expensive. This smoothing of the surface fills up the holes and sheds the water to the side ditches and prevents the roads from ever becoming very bad, and also decreases the labor and time required with the scraping grader later. There is a great difference in the way different men handle the road grader. Some will nearly pull the life out of their horses and do little or no good, others will make lighter work of it and also do more good to the roads. The road machine is a complicated tool, but when properly used it will greatly benefit the roads. Why not have competitive contests to determine the best method of using this excellent tool and to disseminate this knowledge?

There are several ways in which our roads may be improved with very little expense, and when a man starts out to study the roads intelligently he can readily see their defects and needs. For example, it improves a road on a steep grade and also saves expense, to keep it rounded up so as to shed the water into the side ditches instead of permitting it to run down the middle of the road. Second, wherever water stands at the side of the road, better drainage is needed—either an open ditch, or a line of tile, or an inlet into the tile already laid. Third, it is poor economy to make small culverts; say a wooden box 12 inches square, so short as to concentrate travel and cause a mud hole on each side. Fourth, after a long muddy spell when a cold wave has been announced, if the road is dragged a smooth, hard track will result. The drag can be made by splitting a 10-inch round log lengthwise and fastening the two pieces together by nailing cleats on the flat sides, the two logs being about 2 feet apart. This device is to be dragged over the roads round side down.

In conclusion, permit me briefly to summarize what has been said:

1. Experience in road building in other countries or other States is no guide for Illinois, since the road question is a problem to be solved by each local community for itself.

2. It is not reasonable to expect any material improvement in the condition of the roads simply by changing from the labor-tax to the cash-tax system or vice versa.

3. To secure individual responsibility and stimulate personal pride, assign the care of definite sections of the road to individual farmers; and publish the assignments, and award prizes or diplomas for excellence.

4. The harrow or the wooden scraper or the railway rail should be used more than at present.

5. Competitions in operating the road grader would develop the best method of handling that machine.

6. The proper care of our earth roads is worthy the careful thought of all who dwell in the country.

7. An intelligent and active public interest in road affairs will secure greater efficiency in all kinds of road work.

ROAD LAWS OF ILLINOIS.*

BY I. O. BAKER.

ORGANIZATION.

The wagon roads of Illinois are entirely under the control of small and local administrative bodies. The State has 102 counties, all but about 20 of which are under township organization, and in these the public highways are under the sole charge of three elective township officials known as highway commissioners. The townships, usually six miles square, are divided into three districts, for each of which a highway commissioner is elected once in three years. The highway commissioners have almost unlimited powers, except in the amount of the taxes they may assess. The law permits the commissioners to employ a superintendent, but usually each commissioner assumes general oversight of the work in his own district. In townships working under the "labor system," i. e., the system under which part or all of the property road-tax may be paid in labor, the highway commissioners must divide the township into districts and appoint an overseer or "road boss" or "pathmaster" for each, who has oversight of the laborers on the road. In counties not under township organization, the board of county commissioners appoints local road officials, and the result is substantially the same as in counties under township organization.

ROAD TAXES.

There are three forms of road taxes in Illinois: (1) a tax upon the traveler; (2) a capitation tax; and (3) a property tax. The first form of tax leads to toll roads. There never were many toll roads in Illinois, and most of them have been acquired by the public and made free. The capitation tax is in quite general use in Illinois, as well as in most, if not all, of the states of the Mississippi Valley. A poll tax of not less than $1 and not more than $2 per annum may be levied upon all able bodied males between the ages of 21 and 50 years, except that school directors, who receive no pecuniary compensation, are exempt from poll road-taxes, as are the inhabitants of cities and incorporated villages. This tax may be paid in cash or in labor at the rate of $1.25 for eight hours of labor of a man with a spade, axe or shovel. The poll tax may be abolished by a majority vote at the annual town meeting. Under certain conditions, as stated in the next paragraph, the taxes upon property for road purposes may be paid in labor, in which case the poll tax may be not less than one day nor more than three days per annum.

The law makes all property road-taxes nominally payable in cash; but permits the annual town meeting by majority vote to adopt the labor-tax system, and nearly all townships have done so. There are then really two forms of road taxes upon property, the "district road tax" which may be paid in labor, and the "road and bridge tax" which must be paid in cash. The former must be expended in the district from whence collected, but the latter may be spent anywhere in the township. The district road tax is supposed to care for the road and make minor repairs, and the road and bridge tax is expended for bridges, machinery, lumber, tile, etc., and to pay the overseers. The highway commissioners are paid out of general township funds.

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*Written for the Engineering Record.

In townships under the cash road-tax system, the highway commissioners may levy a road tax of 60 cents per $100 of the assessed value of all property, and by special authority of the town auditors an additional 40 cents per $100. In townships under the labor tax system, a tax of 40 cents per $100 may be levied by the commissioners and an additional 40 cents if authorized by the annual town meeting. The assessed valuation is one-fifth of the nominal cash value. Any road taxes collected from property within the limits of cities and villages must be turned over to the authorities of the incorporation, and the incorporation may abolish road taxes within its own limits. When new bridges, even small ones, are to be built it almost invariably is the custom to levy the maximum for at least two successive years preceding. When bridges of considerable size are required, it is usually necessary to issue bonds. Many townships assess the maximum tax year after year, and are continually improving the quality of the roads.

The following table gives the details of the average expenditures in labor and cash for road purposes in 19 townships in a prairie county. It is not known that any similar data were ever before collected, and hence there is no means of knowing whether these data are representative; but it is probable that the expenditures for new bridges is more than the average for the state. There are 1.97 miles of road per square mile of area outside of cities and villages. All the roads have a black loam surface.

AVERAGE EXPENDITURES PER MILE OF EARTH ROADS IN CHAMPAIGN COUNTY, ILLINOIS.

1.	New steel bridges (exclusive of county aid)	$16.20
2.	Drainage	6.32
3.	Tile culverts	1.32
4.	Repairs of bridges and culverts	2.93
5.	Grading (not simply smoothing and leveling)	1.43
6.	Smoothing and leveling (not grading)	2.83
7.	Mowing the roadsides	1.14
8.	Administration	2.69
	Total	$34.86

There are unquestionably some inherent defects in the labor-tax system; but on the other hand there are just as certainly some economic and administrative advantages. Unfortunately its defects are usually magnified, and even misrepresented, while its advantages are entirely ignored. A careful and intimate study of the roads of central Illinois during a dozen years reveals no difference in their quality or cost between townships working under the labor system and those working under the cash system. Good results are found under both systems, and poor results are also found under each system. Good results are never found under either system except under energetic and intelligent commissioners, and then usually only with those having considerable official experience. Generally the communities are willing to continue in office an efficient commissioner, and tenures of 10 to 20 years are not uncommon, and one case is known of a man who served 37 years and declined re-election. It is not true that members of rural communities, at least in Illinois, are not interested in road improvement, for many instances could be cited where men give a good deal more labor than is exacted, and many other instances could be shown where farmers have given largely of money and labor to secure radical improvements in the roads which they use.

HARD-ROAD LAW.

Since 1883 the State has had a law permitting townships to levy a special tax of $1 per $100 for building hard roads. The statute provides all the necessary legal machinery and gives most excellent general directions, including an obligation to have all the work performed under the direction of a competent engineer; but its one vital defect appears to lie in the provision for selecting by a vote of the township the first road to be improved. There is nothing in the law to provide for a continuance of the good work, and it has been found impossible to induce taxpayers on back roads, or those living on roads not likely to become improved thoroughfares, to vote taxes liable to be expended several miles outside their own neighborhood. A want of faith in the township's perseverance appears to be fatal to the execution of the law. A careful and extended inquiry failed to reveal a single instance in which the law had been applied.

STATE AID.

The Illinois legislature meets biennially, and at the session of 1901 a bill was introduced providing for State aid in road building. Considerable skillful and successful missionary work was done before the bill was presented to the legislature, and early in the session there was some promise that it might pass; but the bill was never considered on its merits, even in committee, partly on account of an unusually early adjournment of the legislature. The bill was before the public long enough, however, to arouse active opposition, particularly among the farmers. In the northern third of the State, where there is considerable gravel and stone suitable for macadam roads, the bill was objected to on the ground that they had already built many miles of hard road and hence it was not fair to ask them to help build all the roads in other parts of the State. In the central third, where there is no road building material and where hard roads will be very expensive, the bill was objected to on the ground that hard roads were impossible in that portion of the State and hence the bill would simply compel the central portion to help build roads in the north end of the State. In the southern third, which is not as wealthy as the other portions, the objection was that they could not afford hard roads at any price and consequently the only effect would be to make them help build roads in the other parts. In all parts some of the most intelligent citizens contended that the wagon roads are matters of only local concern and should be left wholly to local authorities. The prospects for the passage of any law for State aid for road building decreased rapidly with the continued discussion of the subject. The former bill was promoted by interests that expected to profit by its enactment, and the fact that no similar bill has been introduced at the session of 1903 probably indicates that those interests have concluded that there is no present hope of getting such a law.

Some wise friends of better roads claim that a law permitting the application of the principle of special assessments and the issuing of bonds would greatly stimulate road improvement. It is certain that a law permitting such co-operation in drainage matters has been of incalculable benefit to the State of Illinois by making possible the construction of long drainage canals which serve as outlets for tile drains. Similar laws in Indiana and Ohio have materially stimulated the building of hard roads in those states. To secure such a law in Illinois applicable to road building would require an amendment to the constitution, and as only two amendments can be submitted each biennial period and as there are numerous interests clamoring for amendments, there is little hope for aid to road improvement from this direction. The cities and incorporated villages do not lack for legal machinery for the improvement of their streets.

PRESENT CONDITION OF THE ROADS.

The wagon roads of Illinois have rapidly improved in recent years, probably as fast as is reasonable to expect and certainly at least relatively as rapidly as the several communities have advanced in other lines, as for example, in education, in agriculture, in house building, or in sanitary science. Many, perhaps most, of the roads have been underdrained, and the surface of nearly all of them has been crowned, and they have fair side ditches. The streams and ditches have been provided with bridges or culverts. In many cases the bridges are substantial steel structures, often with stone abutments; and many of the culverts consist of vitrified pipe. In many communities the road sides are seeded to grass, and are mowed and kept free from unsightly weeds. In recent years there has been a rapid increase in the amount of money spent for drainage, tile culverts, steel bridges, and road machinery. Nevertheless in the spring of the year, particularly just as the frost goes out of the ground, the roads are next to impassable, but tile drainage has materially shortened the period of impassability. Large sums are spent annually to restore the form of the surface after the break up of the spring; but this phase of road work is probably most in need of attention and improvement. Illinois is at least equal to many much older states in the care bestowed upon the surface, in the attention given to the roadside, in the money spent for steel bridges and tile culverts, in the expense incurred for tile drainage, and in the attention given to restoring the surface.

In the northern part of the State, there are about 7,000 miles of hard roads outside of the cities and villages; in the central part there are only about 1,000 to 1,200 miles of hard road; and in the southern part there are 400 to 500 miles of permanently hard roads.

There are a number of ways in which the present methods of road management and road maintenance can be greatly improved, which improvements will redound to the social advantage of all members of the community, but would-be road reformers should be willing to recognize signs of progress and to admit the difficulties in the way of improvements. What is most needed in discussions of the road problem is more light and less heat.

ANNUAL REPORT OF THE EXECUTIVE SECRETARY-TREASURER.

FOR THE YEAR ENDING JANUARY 23, 1903.

To the Members of the Illinois Society of Engineers and Surveyors:

GENTLEMEN: Below is given my report as Executive Secretary-Treasurer for the year ending January 23, 1903:

RECEIPTS.

Balance on hand January 25, 1901	$ 63.32	
Received for Initiation Fees	15.00	
Received for Annual Dues	236.00	
Received from Sale of Reports	21.18	
Received from Advertising	349.88	
Total		$685.38

DISBURSEMENTS.

Printing Seventeenth Annual Report	$318.49	
Stenographer at Seventeenth Annual Meeting	63.00	
Postage and Express	104.18	
Miscellaneous Printing, Cuts for Report, and other expenses	151.74	
Salary Executive Secretary-Treasurer	......	
Balance on hand January 23, 1903	47.97	
Total		$685.38

There is due the Society on advertising $25.

Uncollected dues for 1902 amount to $214. About 50 per cent. of this is collectable. The membership is the same as last year, the new members taking the place of members resigned.

There were 1,600 copies of the Seventeenth Annual Report printed.

Exchanges were made with the following Societies:

Association of Engineering Societies, University of Illinois.
Connecticut Civil Engineers and Surveyors.
Michigan Society of Engineers.
Indiana Society of Engineers.
Engineering Association of the South.

Copies of reports were sent to all members in good standing.

On account of a change of location and extreme pressure of work, the Secretary was not able to give the business of the Society his best attention, and to this he attributes the large amount of uncollected dues. To repair this loss in a small manner the Secretary presents the Society the salary allowed him for 1902.

Respectfully submitted,
A. L. KUEHN,
Secretary-Treasurer.

March 17, 1903.

CONSTITUTION AND BY-LAWS

OF THE

Illinois Society of Engineers and Surveyors

AS AMENDED AND ADOPTED AT THE FIFTEENTH ANNUAL MEETING
HELD AT MOLINE, JANUARY, 1900.

CONSTITUTION.

ARTICLE I.—NAME.

This Association shall be called the Illinois Society of Engineers and Surveyors.

ARTICLE II.—OBJECT.

The objects of this Society are the encouragement of professional improvement and of goodfellowship among its members, by meetings for the presentation and discussion of papers on scientific and other kindred topics, and the discussion of such other subjects as may be of interest to its members; the publication of such parts of its proceedings as may be deemed expedient; and the collection and preservation of books, maps, drawings, and other articles of value to the professions represented in its membership.

ARTICLE III.—MEMBERSHIP.

SECTION 1. Any engineer, architect, surveyor or person directly engaged in the designing, construction or maintenance of engineering or public works is eligible to membership; and any person who is engaged in the sale or manufacture of any supplies or materials used in engineering construction is eligible to associate membership.

SEC. 2. Each candidate for membership or associate membership shall make application in writing to the Executive Secretary on a printed form provided therefor by said Secretary. Such application shall state in writing the name, age, residence, present occupation and the nature and extent of professional service of the applicant; and must be endorsed by three members of the Society. The application shall be accompanied by a deposit of Three Dollars ($3.00) to be applied on account of the admission fee, if the applicant be elected, or refunded if he be not elected.

SEC. 3. Whenever any application for membership shall be received by the Secretary, a copy thereof shall be submitted to the members of the Executive Board within one month from date of the receipt of the same.

It shall be the duty of each member of the Executive Board within ten (10) days from the receipt of any such application, to send his vote upon the electing of such person to membership to the Executive Secretary. PROVIDED, that any applications received within two (2) months immediately preceding any regular meeting of the Society shall be submitted by the Secretary of the Executive Board at its session immediately preceding such meeting of the Society. Four (4) affirmative votes shall elect such person to membership.

The Executive Secretary shall include in his report to the Society the names and postoffice addresses of all persons elected.

SEC. 4. Any person may be elected an honorary member, by a unanimous ballot of all the members, not less than twenty in number, present at any regular meeting of the Society.

Honorary members may present papers and take part in all discussions, and shall be entitled to receive, on request made in writing each year, copies of the annual report of the proceedings of the Society, but they need pay no initiation fee nor dues, and shall have no vote.

SEC. 5. Any three members may present to the Executive Board charges in writing affecting the moral or professional character of any member, whereupon the said Board shall notify the member of such charges, and shall appoint a time and place at which the accusers and the accused may be heard. On an affirmative vote of at least four members of the Board, the charges shall be presented to the Society as soon as it shall be in session, all parties being duly notified, and having opportunity to be heard. On an affirmative vote of three-fouths or more of the members present, said affirmative vote being not less than eighteen in number, said member shall be expelled, and his name shall be struck from the roll; but no public notice of such proceedings shall be given.

SEC. 6. The annual assessment shall be due and payable in advance, and no publications of the Society shall be forwarded to any member till such annual dues be paid.

Any member who shall refuse or neglect for one year after the annual meeting to pay any dues or assessment due from him, shall cease to be a member, and his name shall be struck from the roll. He may be reinstated on payment of the sum so due and of all further sums which would have been due from him had he remained a member up to the time of such reinstatement.

ARTICLE IV.—OFFICERS.

SECTION 1. The officers of this Society shall be a President, a Vice-President, an Executive Secretary-Treasurer and Board of Trustees. The above named officers shall constitute the Executive Board, of which the President shall be ex-officio chairman, and the Executive Secretary ex-officio Secretary.

Two Trustees shall be elected annually and hold office for two years.

SEC. 2. All officers except the Executive Secretary-Treasurer shall be elected annually by ballot by the members, on the second day of the annual meeting, and shall hold office until their successors are elected and qualified.

The Executive Secretary-Treasurer shall be elected annually by the Executive Board.

SEC. 3. The President, Vice-President, Executive Secretary-Treasurer, shall perform the duties usually pertaining to their several offices. The Executive Secretary-Treasurer shall be the custodian of all property of the Society, and shall deliver all such property to his successor, and shall make an annual report. He shall record the proceedings and discussions of the meetings, and shall prepare a copy of them for publication.

As Treasurer, he shall give bond with two approved sureties to such amount as may be required from time to time by the Executive Board, and his bond when approved by said Board, shall be copied on the Journal of the Society, and be deposited with the President. He shall pay only such orders as have been signed by the President, Executive Secretary, and shall make an annual report of all receipts and expenditures, and shall deliver all the Society's books and money in his possession to his successor. The Executive Secretary, in addition to the duties usually pertaining to his office, shall be ex-officio Librarian of the Society, and as such shall collect and preserve all books, pamphlets, papers and documents belonging to the Society. The library of the Society shall be kept in some place central and convenient to access by railway. He shall deliver all the property of the Society in his possession to his successor.

SEC. 4. The Executive Board shall audit the accounts of the Treasurer and determine the assessment per member for the following year immediately before each annual meeting, and make annually a report to the Society. They shall arrange the program of exercises for each annual meeting and shall have a general care over the affairs of the Society, and shall act for the Society in all general matters between the annual meetings. No moneys shall be expended without a vote of the Executive Board.

SEC. 5. There shall be appointed at each annual meeting the following standing committees of three members each: (*a*) Committee on Surveying; (*b*) Committee on Roads and Pavements; (*c*) Committee on Railways; (*d*) Committee on Water Works; (*e*) Committee on Drainage; (*f*) Committee on Sewers; (*g*) Committee on Exhibits; (*h*) Committee on Press. It shall be the duty of each committee to collate facts, figures, and items of interest in their respectve departments, and make at least one formal report to the Society at the annual meeting following their appointment. The chairman of each committee shall solicit, under the direction of the Executive Board, papers for the annual meeting, and advise with said Board in matters relating to the general subject of the committee's work.

ARTICLE V.—PUBLISHING ANNUAL REPORTS.

The Executive Board shall compile and publish the annual report of the transactions of the Society. They shall include in this report all items of general interest in the proceedings, and such other matters as may seem to them advisable.

ARTICLE VI.—COMPENSATION OF OFFICERS.

The Society may provide for the compensation of its officers for their services whenever deemed advisable.

ARTICLE VII.—AMENDMENTS.

All propositions for amendments of this constitution shall be referred to the Executive Board who shall report to the Society before final adjournment of the annual meeting, and such amendment shall be declared adopted by an affirmative vote of two-thirds of the members present, not less than fifteen members voting.

BY-LAWS.

SECTION 1. The annual meetings of this Society shall be in such place as shall be determined by this Society at each previous meeting and at such time in January as shall be determined by the Executive Board. The Executive Board shall notify each member of the Society at least twenty days before the annual meeting.

SEC. 2. Ten members shall constitute a quorum for the transaction of business.

SEC. 3. The meetings of this Association shall be governed by "Robert's Rules of Order."

SEC. 4. The order of business shall be fixed by the Executive Board.

SEC. 5. A record of all donations to the Society whether in money, books, maps, models, or other articles of value, with names of the donors, shall be entered by the Executive Secretary in a book provided for that purpose.

SEC. 6. These By-Laws may be amended by a two-thirds vote of the members present at any annual meeting, not less than fifteen members voting.

Duane Doty

Born in 1835
Died Nov. 17, 1902

During the year 1902 the Society suffered a loss by the death of Mr. Duane Doty, of Pullman, Ill.

He was born at Amherst, O., in 1835; attended the Academy at Ann Arbor, Mich., and graduated from the University of Michigan in 1859. He joined the Army when the Civil War broke out, being commissioned in 1861 as Adjutant of the Seventh Michigan Cavalry (which regiment he had helped to organize). He served in the Army of the Potomac, and before the close of the war was promoted as Adjutant-General of General Pleasanton's Division.

In 1868 he was made Superintendent of Public Schools at Detroit, Mich., and in 1872 moved with his family to Chicago, where he received a similar appointment.

As a surveyor and civil engineer, he assisted in laying out the model industrial town of Pullman, and was associated with the Pullman Company for several years. In 1897 he was also consulting engineer for the American Sectional Cannon Co.

He was elected a member of the Illinois Society of Engineers and Surveyors in 1898.

LIST OF ENGINEERS AND SURVEYORS OF ILLINOIS.

(Those marked with a star * are members of the Illinois Society of Engineers and Surveyors.)

NOTE—In order that this list may be made complete and accurate, members are urged to examine it and to send any additions or corrections to the Secretary.

Joel Brown	Albion
*F. Oswald	Alhambra
H. C. Freeman	Alto Pass
Geo. Dickson	Alton
T. M. Long	Alton
F. W. Olin	Alton
E. E. Rutledge	Alton
H. C. Swift	Alton
C. B. Stewart	Anchor
Thomas Shore	Atlanta
*H. D. Hallett	Aurora
Robert Horr	Aurora
R. Nichols	Aurora
M. G. Stolp	Aurora
C. Tarbell	Aurora
F. W. von Oven Love Bros. Ir. Wks.	Aurora
M. H. Wickhorst C., B. & Q. Ry.	Aurora
E. K. Meredith	Batavia
*T. W. Snow	Batavia
*C. H. Sexton	Beardstown
Louis Graner	Belleville
G. Hilgard	Belleville
W. A. Reiss	Belleville
A. Rosanko	Belleville
Charles Buchanan	Bellmont
*J. R. Jaffray	Belvidere
*W. M. Marean	Belvidere
*W. J. Day	Bement
Phillip Langer	Benton
*A. H. Bell	Bloomington
W. P. Butler	Bloomington
*Elmer Folsom	Bloomington
*J. G. Melluish	Bloomington
Ira Merchant	Bloomington
G. L. Moore Eng. M. of Way, C. & A. Ry.	Bloomington
J. Link	Blue Island
P. R. Fletcher	Blue Island
H. E. Boehn	Braidwood
Martin Brown	Cairo
W. M. Johnston	Cairo
Wm. Thrupp	Cairo
Harry Bond	Canton
*G. W. Chandler	Canton
Thomas Bacon	Carlinville
F. A. Chapman	Carlinville
Alex. Johnson	Carlyle
M. W. Spencer	Carmi
Geo. W. Page	Carthage
*I. O. Baker, U. of Ill.	Champaign
*O. L. Gearhart	Champaign
*M. S. Ketchum, U. of I.,	Champaign
*C. W. Malcolm, U. of I.,	Champaign
*L. G. Parker, U. of I.	Champaign
*W. H. Tarrant	Champaign
Z. Green	Charleston
W. E. Millar	Charleston
J. T. Douglas	Chester
S. N. Thompson	Chester
(See separate list for Chicago.)	
David Richardson	Clinton
R. L. Kneedler	Collinsville
J. H. Brink	Crystal Lake
W. H. Butterfield	Dakota
Alex. Bowman	Danville
*C. E. Ellsworth	Danville
F. W. Hawks Asst. Eng., C. & E. I. Ry.	Danville
W. H. Martin	Danville
R. Y. Maxon	Danville
Sullivan Burgess	Decatur
J. K. Howard Res. Eng., Wab. Ry.	Decatur
Geo. V. Loring	Decatur
*W. M. Hay	De Kalb
A. M. Shaw Dek. & S. W. El. Ry.	De Kalb
C. V. Kerch	Dixon
C. F. Nesbit	Dixon
Geo. T. H. Shaw	Dixon
R. P. Morgan	Dwight
C. L. Baker	East St. Louis
H. W. Cox Chf. Eng., Wiggins Ferry Co.	East St. Louis
L. L. Harper	East St. Louis
E. S. Helm	East St. Louis
*J. S. Parr	East St. Louis
J. B. Jones	Effingham
A. S. Moffitt	Effingham
*W. W. Abell	Elgin
W. A. Gabriel	Elgin
A. Mann	Elgin

J. T. W. Jennings.........Evanston
John H. Moore...........Evanston
C. J. Morse...............Evanston
Adam Crouch ....Fairfield
C. H. Rankin............Fall Creek
*G. W. Graham............Freeport
F. E. Josel................Freeport
*O. T. Smith...............Freeport
J. B. Ginn..................Galena
F. J. Allen...............Galesburg
G. T. Bell................Galesburg
A. T. & S. F. Ry.
*F. M. Connolly..........Galesburg
*John B. McAuley.........Galesburg
E. Murphy ....Galesburg
Div. Eng., C., B. & Q. Ry.
A. Ritchey ....Galesburg
*L. Z. Jones..................Galva
M. G. Barnes..............Geneseo
U. S. Asst. Eng.
Kirk Martin ....Geneseo
H. B. Alexander............Geneva
W. H. Pease................Geneva
C. G. Elliott................Gilman
J. H. Murphy.............Glendale
Geo. Cole................Golconda
Asst. Eng., I. C. Ry.
W. T. McCormick........Golconda
C. H. Rauchfuss..........Golconda
R. K. Dewey............Greenville
R. E. Williams.............Harlem
I. C. Abney.............Harrisburg
W. A. McHenry.........Harrisburg
T. D. Hobson..............Harvey
J. R. Faulkner.............Havana
L. S. Thorp....................Hitt
C. E. Ellsworth.........Hoopeston
*G. W. Gastman............Hudson
B. F. Bond............Jacksonville
Chf. Eng., J. & St. L. Ry.
C. W. Brown..........Jacksonville
E. H. Crampton........Jacksonville
L. S. Olmsted..........Jacksonville
S. B. Stewart..........Jacksonville
Walter Hansell ....Jerseyville
A. W. Newton...........Jerseyville
F. C. H. Arentz..............Joliet
Jol. Bge. & I. Co.
*G. W. Brown................Joliet
A. Comstock ....Joliet
A. Montzheimer ....Joliet
Chf. Eng., E. J. & E. Ry.
*R. E. Orr.....................Joliet
*H. A. Stevens...............Joliet
*Noah Whitley ....Joliet
C. V. Brainard..........Kampsville
U. S. Asst. Eng.
R. D. Gregg.............Kankakee
D. Nolan, I. I. & I. Ry....Kankakee

W. R. Sanborn...........Kankakee
I. I. & I. Ry.
G. P. Smith..............Kankakee
Eng. M. of W., I. I. & I. Ry.
J. E. Shepardson.........Kankakee
W. H. Woodruff.........Kankakee
I. C. Banister.............Kewanee
*J. E. Kemp...............Kewanee
*J. C. Quade...............Kewanee
M. F. Davidson..........Kirkwood
G. F. Wrightman..............Lacon
*R. C. Vial...............La Grange
W. B. Ewing............La Grange
S. A. Sterns.............La Harpe
J. H. Dunbar..............La Salle
M. & H. Zinc Co.
J. W. Hegeler.............La Salle
M. & H. Zinc Co.
*C. H. Nicolet..............La Salle
M. & H. Zinc Co.
E. J. Noonan..............La Salle
*E. H. Whittaker...........La Salle
H. G. Buchanan......Lawrenceville
J. B. Bertolet...........Leaf River
D. S. Braucher.............Lincoln
T. S. Davey................Lincoln
*L. J. Sims..................Lincoln
*John Zeter ....Lincoln
Wm. Bates ....Litchfield
*G. M. Clark.............Low Point
*J. M. McNabb.............McNabb
*C. Holmes ....Macomb
J. F. Shannon.............Macomb
*J. F. Schmeltzer..........Manteno
J. E. Bond...............Marseilles
A. Nichols ....Marseilles
E. J. Ward..............Marseilles
Lewis Pulley ....Marion
W. M. Duane.............Mattoon
Sup. Cons., C., C. C. & St. L. Ry.
*A. C. Loomis..............Mattoon
W. E. Miller..............Mattoon
L. S. Rose.................Mattoon
E. M. of W., C., C. C. & St. L. Ry.
*J. Withington ....Mattoon
D. A. Spaulding...........Melville
W. F. Whitmore..........Mendota
C. A. Geltner.......Metropolis City
C. L. Crabbs................Moline
*D. Gordon ....Moline
M. A. Gould................Moline
R. W. Jones................Moline
*H. G. Paddock.............Moline
O. J. Root..................Moline
*J. L. Clark...............Momence
*A. W. Gates............Monmouth
*Thos. McClanahan ......Monmouth
*J. E. Miller.............Monmouth
John Burmeister ....Morris

J. B. Mathias..........Mound City
R. A. Buchanan.........Mt. Carmel
Paul Hamilton..........Mt. Carmel
E. M. of W., C., C. C. & St. L. Ry.
G. C. Harvey...........Mt. Carmel
L. S. Thorp............Mt. Carroll
J. W. Ewing...........Mt. Pulaski
Kirby Smith ....Mt. Vernon
W. T. Williams........Mt. Vernon
R. G. Harris..........Murphysboro
Geo. Kennedy, Jr......Murphysboro
Wm. Kilgore ....Newton
G. B. Herrington...........Normal
Wm. Iken ....Oak Park
D. F. Tiedeman...........O'Fallon
Bryant Higgins ....Olney
Frank Nuding ....Olney
M. G. Voris................Oneida
E. L. Moffett.............Oquawka
Thomas Jakeman ....Oregon
Alfred Dunaway ....Ottawa
W. E. Stricker.............Ottawa
Chas. F. Wilson...........Ottawa
T. J. Brooks.................Paris
D. H. Sawyer................Paris
*W. C. Lemen..................Paris
Wm. McMahon ....Paw Paw
*J. T. Stewart...............Paxton
*D. H. Jansen.................Pekin
T. A. Giltner..............Pellonia
Daniel Allen ....Peoria
*C. G. Anderson..............Peoria
*H. E. Beasley...............Peoria
Clay Belsley, M. E...........Peoria
J. C. Bell....................Peoria
Asst. Eng., P. & P. U. Ry.
*O. L. Dubuis................Peoria
*C. H. Dunn..................Peoria
*W. C. Evans.................Peoria
*J. A. Harman................Peoria
A. Lagron ....Peoria
P. & P. Term. Ry.
*D. H. Maury.................Peoria
N. V. Perry..................Peoria
C. S. Millard................Peoria
Chf. Eng., P. & P. U. Ry.
*A. D. Thompson............Peoria
A. H. Neureuther.............Peru
C. W. Richard.................Peru
Frank V. Alkire.........Petersburg
*J. A. Davison..................Polo
*P. C. Knight...............Pontiac
R. Hodgman.............Princeton
J. C. Long...............Princeton
U. S. Asst. Eng.
A. Twyman ....Pullman
E. H. Arnold................Quincy
Q. & W. Ill. El. Ry.
Enoch R. Chatton...........Quincy

G. A. Grocer................Quincy
F. L. Hancock...............Quincy
Thos. Hill, M. E............Quincy
E. Prince ....Quincy
H. C. Webster...............Quincy
Geo. Wolcott ....Quincy
G. W. Clark...............Rochelle
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NINETEENTH ANNUAL REPORT

OF THE

ILLINOIS SOCIETY

OF

ENGINEERS AND SURVEYORS

PROCEEDINGS OF THE SOCIETY

AT THE

NINETEENTH ANNUAL MEETING

HELD AT

CHAMPAIGN, ILLINOIS, JANUARY 20, 21 AND 22, 1904

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1904

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Quade, John C., Civil Engineer for Western Tube Co.................. ....102 N. Burr St., Kewanee

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Rudolph, Emil, Land Surveyor............Room 408, 112 Clark St., Chicago

Sawyer, D. H., Danville, Urbana & Champaign Electric Ry.........Danville

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Sherman, Leroy K., Civil Engineer.............1107 Leland Ave., Chicago

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Sims, Lewis J., Drainage Engineer and Surveyor..627 Lincoln Ave., Lincoln

Slocum, Roy H., Instructor in Theoretical and Applied Mechanics, University of Illinois.........................926 W. Illinois St., Urbana

Smith, Owen T., Engineer and Superintendent for Water Company..Freeport

Snow, T. W., Manager, The Otto Gas Engine Works.360 Dearborn St., Chicago

Stevens, Hubert A., City Engineer...............104 Burttison St., Joliet

Stewart, John T., Civil Engineer (U. S. Geological Survey)........Paxton

Stowell, Charles C., Civil Engineer..........328 N. Fourth St., Rockford

Talbot, Arthur N., Professor of Municipal and Sanitary Engineering, University of Illinois..Urbana

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Tarrant, Wm. H., Chief Engineer, Illinois Central Traction Co., and St. Louis & Springfield Electric Ry Co.........................Springfield

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Withington, J., Surveyor.........................115 So. 17th St., Mattoon
Wightman, George F., Civil Engineer.........................Lacon
Zeter, John, County Surveyor.........................Lincoln

SUMMARY.

Number of members 1903	...	123
Number of new members	15	....
Number of members lost (died, 1; resigned, 2; others, 2)	5	....
Net gain	10	
Number of members 1904		133

PAST PRESIDENTS.

Ira O. Baker	1886 and 1887	Charles C. Stowell	1896 and 1897
C. G. Elliott	1888 and 1889	Almon D. Thompson	1898 and 1899
Arthur N. Talbot	1890 and 1891	Charles C. Brown	1900
Samuel S. Greeley	1892 and 1893	Henry G. Paddock	1901 and 1902
Daniel W. Mead	1894 and 1895	John W. Alvord	1903

Charles E Ellsworth

Died: March, 1903

During the year 1903, the Society suffered a loss by the death of Mr. Charles E. Ellsworth, County Surveyor, of Danville, Ill.

NOTICES.

ANNUAL MEETING, 1905.

The Twentieth Annual Meeting will be held at Chicago, on January 20, 21 and 22, 1905.

It is expected to make this a specially interesting meeting, with excursions, etc., and it is hoped that there will be a large attendance.

Due notice will be given as to the program, accommodations, etc.

COMMITTEES.

Cards have been sent out giving the names of the members of the several committees, and the members of each committee are asked to meet or correspond with each other in regard to their plans of work, and also to assist in the preparation of the reports.

Individual papers will be welcome, and members are invited to prepare papers and so share in the work.

It is very desirable that there should be a strong list of papers and reports for the meeting. Papers and reports should be in the hands of the Secretary by December 31, to give time for arranging the program.

MEMBERSHIP.

Members are urged to interest their friends in the Society and invite them to become members. Applications for membership may be made to the Secretary at any time.

Members receive the Proceedings of this Society and also of some eight or ten other societies of engineers and surveyors.

Entrance fee (to be sent with application)	$3.00
Annual dues, first year	2.00
Annual dues, each year after	4.00

ADVERTISEMENTS.

A large and varied list of advertisements accompanies this report and members are asked to look these over, as being interesting and instructive as well as commercially useful.

In writing the advertisers for information, etc., please mention that you have seen their advertisements in the Report of the Illinois Society of Engineers and Surveyors.

PROCEEDINGS

OF THE

NINETEENTH ANNUAL MEETING

OF THE

Illinois Society of Engineers and Surveyors

HELD AT

CHAMPAIGN, ILL., JANUARY 20, 21 AND 22, 1904.

JANUARY 20. AFTERNOON SESSION.

The Nineteenth Annual Meeting was called to order at 2 p. m. in the Physics Hall of the Engineering Building of the University of Illinois, by the President, Mr. John W. Alvord.

Prof. I. O. Baker: I am very glad to offer a welcome to this Society on behalf of my associates of the engineering faculty of the University of Illinois. The Society first met at this institution in 1887. It has been back frequently since, and it is always welcome. As some of you may not be familiar with the organization of the University it may be permissible for me to say that the University consists of several colleges. We have the College of Engineering, the College of Agriculture, the College of Law, the College of Literature and Arts, the College of Science, and also the School of Music and the Library School. In Chicago there are the College of Medicine (including the School of Pharmacy), and the College of Dentistry, recently acquired. Altogether the University has 3,850 students, and will have over 4,000 before the close of the year. In point of attendance at the great universities of the country, the University of Illinois ranks sixth. The number of students in the College of Engineering is 784. There are something over 650 women students. It is with some pride we say that 50 more than one-half of the men students in the University are students of engineering. There are but three (perhaps only two) institutions in the country that have more students of engineering than the University of Illinois.

An address on "The College of Engineering," University of Illinois, was then delivered by the Dean of that College, Prof. N. C. Ricker. This was followed by the annual address of the President.

The first paper was on "Municipally Owned Water, Gas and Electric Light Plants," by Mr. T. E. Herdman, which was read by the Secretary, in the absence of the author. Three papers on concrete work were then presented, as follows: "Concrete for Farm Work," by L. Z. Jones; "Concrete Foundations for Pavements," by O. L. Gearheart; "Effect of Manure on Masonry and Concrete Work," by L. A. Waterbury. A general discussion on concrete followed.

Mr. H. G. Paddock moved that the Executive Board be instructed to inquire into and determine the feasibility and advantage of incorporating the Society. This was carried and the meeting then adjourned.

JANUARY 20. EVENING SESSION.

The meeting was called to order at 7 p. m., and Mr. F. C. Amsbary read a paper on "The Waterworks of Champaign and Urbana." Mr. H. M. Ely read a paper on "The Danville Waterworks Dam"; Mr. J. F. Parr read a paper on "Floods and Flood Protection Works at East St. Louis"; and a paper by Mr. O. F. Dubuis on "The City Park of a Medium Sized Town," was read by the Secretary in the absence of the author. The Secretary also presented the report of the Committee on Architecture and the report of the Committee on Mechanical and Electrical Engineering. The meeting then adjourned.

JANUARY 21. MORNING SESSION.

The meeting was called to order at 9 a. m., Mr. H. G. Paddock (Past President) being in the chair. The report of the Committe on Roads and Pavements was read by Mr. Paddock, Chairman of the Committee, and Prof. I. O. Baker read a paper on "Illinois Engineers and Illinois Highways."

The President, Mr. Alvord, then took the chair, and a paper on "The Illinois Good Roads Commission," by Mr. D. W. Smith (Chairman of the Commission), was read by the Secretary in the absence of the author. In the discussion, Mr. Melluish spoke in favor of the Brownlow bill, and (on motion of Mr. Paddock), Mr. Melluish was asked to prepare a resolution as to this bill. This resolution, however, did not come before the Society for action. On motion of Prof. Baker a committee composed of Prof. Talbot, Mr. Paddock and Mr. Jones was appointed to prepare a resolution upon the work of the Good Roads Commission.

Four more papers on the road question were then read: "Present Practice in Stone Road Construction in Northern Illinois," by Mr. A. L. Waterbury; "Road Construction in Massachusetts, New Jersey and Connecticut," by Mr. L. G. Parker; "The Road Laws of Illinois," by Mr. R. I. Webber; and "Recent Legislation on the Road Question in Several States," by Mr. E. E. R. Tratman. The report of the Committee on Surveying was then read by Mr. Melluish, Chairman of the committee. The meeting then adjourned.

JANUARY 21. AFTERNOON SESSION.

The meeting was called to order at 2 p. m., by the President, Mr. J. W. Alvord, who appointed the Nominating Committee, as follows: Prof. Talbot, Mr. C. G. Elliot and Mr. H. G. Paddock. The Secretary then read the report of the Executive Committee, and the report of the Secretary and Treasurer.

A paper on "Drainage and Irrigation in the Central States" was read by Mr. C. G. Elliott (Past President). A paper on "The Work of the U. S. Geological Survey in Illinois," by Mr. M. O. Leighton, was read by the Secretary, in the absence of the author. The President called for the report of the Committee on Sewers, but Mr. Chandler, the Chairman, announced that the committee had no report. Prof. Talbot then read a paper on "The Measurement of Flow in Sewers," and Mr. Royal Sawyer showed some stereopticon views of sewage purification plants.

The meeting then adjourned and the members made a tour of the several departments of the University, under the guidance of Professors Baker, Talbot and Breckenridge.

JANUARY 21. EVENING SESSION.

The meeting was called to order at 7:30 p. m., by the President. The report of the Committee on Drainage was read by Mr. J. L. Clark, Chairman of the committee. A paper on "The Hennepin Canal," by Mr. J. C. Long, was read by the Secretary in the absence of the author. An interesting address on "Some Recent Waterworks and Water Power Installations," was given by Mr. D. W. Mead, and was illustrated by a large number of stereopticon views. The meeting then adjourned to the faculty rooms, where an informal reception was held.

JANUARY 22. MORNING SESSION.

The meeting was called to order at 8:30 a. m., by the President. The Nominating Committee presented the following nominations for officers for 1904:

President—J. W. Alvord.
Vice-President—C. H. Nicolet.
Trustees—W. M. Hay, J. E. Kemp.

The Secretary was instructed to cast the ballot and the above officers were duly elected.

The committee appointed to report on the Good Roads Commission reported through its Chairman, Prof. Talbot, the following resolution, which was adopted:

RESOLUTION: GOOD ROADS COMMISSION.

Resolved, That the Illinois Society of Engineers and Surveyors desires to express its appreciation of the work of the Good Roads Commission of Illinois, and to express its sympathy and interest in the movement. It also offers its co-operation, and desires to express the hope that the movement will prove of lasting benefit to the road interests of the State.

For the place of meeting in 1905, three nominations were made: Chicago, University of Illinois and Danville. A ballot was taken and Chicago was selected. The Executive Committee announced that Mr. E. E. R. Tratman had been re-elected as Secretary and Treasurer.

A paper on "Municipal Waterworks and Electric Light Plant at Paris, Ill.," was read by Mr. D. H. Sawyer. Mr. G. I. Herrick read a paper on "Some New Inventions in Engineering Measuring Instruments," and the last paper was on "The Economy and Accuracy of Various Methods of Leveling," by Mr. L. A. Waterbury.

The following resolution was then introduced by Mr. L. Z. Jones, and was carried unanimously:

RESOLUTION OF THANKS.

Resolved, That the Illinois Society of Engineers and Surveyors extends its thanks to the faculty and students of the College of Engineering of the University of Illinois for the courtesies and help extended to make the Annual Meeting pleasant and profitable. We desire to mention particularly the short course in engineering, which has correctly and widely extended our learning on engineering subjects.

The meeting then adjourned until the annual convention of 1905.

NEW MEMBERS.

The following new members were elected during the meeting: W. H. Allen, H. M. Ely, R. D. Gregg, C. R. Henderson, G. I. Herrick, C. C. Lakin, A. H. Marshall, A. F. Nichol, J. O'Brien, G. L. Sawyer, A. C. Schrader, I. W. Troxel and L. A. Waterbury.

JANUARY 22. EXCURSION.

After adjournment the members and society went in a body to Danville, a special train on the C., C., C. & St. L. Ry. being provided by the courtesy of Mr. F. W. Butterworth, General Manager of the Western Brick Co., who also entertained the party at lunch at the Plaza hotel. After lunch, a special car, provided by the courtesy of Mr. L. E. Fischer, General Manager of the Danville, Champaign and Urbana Electric Railway, took the party to the Danville waterworks to inspect the new dam and mechanical filtration plant, built under the direction of Mr. Daniel W. Mead. The car then took them to the works of the Western Brick Co., where they inspected the shale pits, the brick mills (for building and paving brick), the drying rooms, and the kilns. They then returned to the hotel, and were given a dinner by Mr. Butterworth, after which they returned to Champaign on the special car. The following resolution of thanks was unanimously adopted at the dinner:

RESOLUTION OF THANKS (EXCURSION).

Resolved, That the Illinois Society of Engineers and Surveyors desires to express its appreciation of the pleasant and profitable excursion kindly furnished by Mr. F. W. Butterworth, General Manager of the Western Brick Co., and its pleasure in visiting the company's model plant. It desires specially to record its appreciation of Mr. Butterworth's kindly hospitality.

Resolved, That the thanks of the Society are tendered also to Mr. L. E. Fischer, General Manager of the Danville, Urbana & Champaign Electric Ry., for furnishing transportation to the waterworks and the plant of the Western Brick Co., and for other courtesies extended.

THE COLLEGE OF ENGINEERING: UNIVERSITY OF ILLINOIS.

BY N. C. RICKER, DEAN OF THE COLLEGE.

On my admission as a student in this College of Engineering 34 years ago, I found an institution planned on the same general lines as at present, with a few dozen students in different departments of engineering, but still without any regular professors devoting their chief attention to the work of instruction in any professional course. Classes in surveying, mechanics and drawing had already been formed, and there was a small carpenter's shop for making repairs and extensions of the existing few buildings, not one of which is now standing. Prof. Robinson took charge of the Department of Mechanical Engineering at the same time and opened the first shop connected with any educational institution in the United States for instructing students in the practical working of wood and metals, and he also opened classes in mechanical engineering, the first engineering department instituted here.

At the beginning of the next University year, Prof. Webb took charge of the Department of Civil Engineering and was later succeeded by Prof. Baker. The Department of Architecture was practically organized in 1873 and that of Mechanics and Municipal and Sanitary Engineering was established by Prof. Talbot somewhat later. Electrical engineering was first added in 1891, by Prof. Stratton, and Railway Mechanical Engineering by Prof. Breckenridge a few years since.

These few facts will serve to remind you of the existence of this College of Engineering for nearly 34 years, and that it grew very slowly during more than 20 of its first years, although hard and earnest work was done by professors and students, and many excellent engineers were prepared for their later professional labors. The value of the engineering professions to the public was not then appreciated, and the ultimate ambition of young men with engineering tendencies was to join a railway surveying party or to attain the proud position of a locomotive engineman. Very little was popularly known then of the work of the engineer, of his personal trustworthiness, and of his capacity to plan and direct great public improvements and enterprises. Therefore it was very difficult to obtain the money required to house the classes and to provide the costly equipment needed for practical and experimental work.

At the beginning of the administration of President Draper, ten years since, conditions had materially improved, since the appropriation had just been made for the Engineering building, which was commenced at that time. Less than 300 engineering students were in attendance, the classes were crowded into some rooms in University Hall, but the College did have a large shop, which sufficed for the time. No special appropriations for equipment of the college with the necessary apparatus had then been made by the State. Great advances have been made during the administration of President Draper, and under his inspiration and guidance. Every building now occupied by the College of Engineering has been built during that period, and very nearly all the equipment now in use has been also provided, by means of generous appropriations made for that purpose by the State. Better even than this, the attendance has increased from less than 300 to almost 800, an average of 16% increase per year, although this increase for the current year amounts to about 28%. Yet there still appear to be abundant opportunities for graduates; indeed, it continues to be impossible to satisfy the demand for able and well trained engineers in all branches of employment.

Since the increasing attendance of students required a large extension of equipment, it became necessary to apply to the State at the last session of the Legislature for an increased appropriation for extending the plant of the college sufficiently to provide the necessary opportunities for undergraduates, and also to enable instructors and advanced students to engage largely in some very promising lines of original investigation. This application was aided by the influence of students and graduates, and especially by that of members of the engineering societies, together with the leading business men engaged in all kinds of industrial enterprises, often managed by or employing engineers. The very liberal sum of $150,000 was appropriated for extending the equipment of this college during the next two years. From this, $30,000 was assigned to provide the additional equipment needed by the undergraduate students.

The wisest use of the remainder was a difficult problem, requiring most careful consideration. It is at once evident that the regular undergraduate instruction should be enriched and invigorated wherever possible. Also that professors may have time to fully develop courses for postgraduate instruction. Further, that at least as good an equipment for postgraduate students needing the use of costly special machines and apparatus should be provided, as can be found at any other college of engineering in this country. Of even greater importance is the study and possible solution of some of the great problems which now interest progressive engineers, and which will vitally affect the future development of this great State. This means the making of original experiments and investigations on a large scale, in the endeavor to extend the borders of scientific knowledge, hoping to discover new facts, which can be utilized for the improvement of the material welfare of the people of the State, the extension of its manufactures and industrial interests, and in the more economical use of its natural resources.

After lengthy consideration of this problem, it was finally decided by the President and Trustees, on Dec. 8, 1903, that the establishment of an Engineering Experiment Station would be the most efficient method for accomplishing all these desired results. This is the first engineering experiment station ever founded by an engineering college in the United States, perhaps in the world. If it can become as useful to the varied interests in this State, which are largely connected with engineering, as the Agricultural Experiment Station of this University has been to the agricultural and horticultural interests of Illinois, its establishment marks the beginning of a great period of development and growth in engineering. The interests affected equal those of agriculture and horticulture in the value of invested capital, and probably in the numbers of persons dependent thereon. There are fewer contingencies beyond human control in engineering than in agriculture, so that results obtained may probably be reduced to greater certainty in practice. Therefore, it is certainly permissible to expect this Engineering Experiment Station to become of vital importance.

No separate building will be required for this work for some years, but it has been decided to build a new foundry costing $10,000, in order to enlarge the forge and machine shops sufficiently for existing needs. Also to erect a Mechanical Engineering Laboratory, costing $20,000, to receive the machines and apparatus required for investigations in steam, gas, and gasoline; superheated steam; heating and ventilation of buildings: refrigeration: compressed air, etc. This will be the most comprehensive experimental laboratory of the college, since nearly all work, except testing the strength of structural materials, experiments in hydraulics, investigations in electrical engineering, and researches in the field of physics, will be made therein. To erect these buildings and provide the necessary equipment of machines, mostly built to order, will require a year, so that the work of the Station will not be in full course before the end of that time.

Investigations are now in progress on the following topics, among others:

A. In Architectural Engineering: (1) Concrete-steel construction. (2) Transmission of heat through insulating material. (3) Refrigeration.

B. In Civil Engineering: (4) Relative values of crushed stone sand and natural sand for mortars and cements. (5) Concrete highway bridge floors. (6) Yield of concrete. (7) Strength of very lean concrete. (8) Strength of neat cement as affected by water. (9) Burnt clay in concrete. (10) Holding power of drift bolts.

C. In Electrical Engineering: (11) Fatigue of eyes by alternating incandescent lamps. (12) Long distance transmission of power.

D. In Mechanical Engineering: (13) Illinois coals used with different types of mechanical stokers. (14) Cutting speeds of high speed tool steels. (15) Power required to drive machine tools. (16) Flow of superheated steam through orifices of different forms.

E. In Applied Mechanics: (17) Strength of large concrete beams with inserted steel tension bars. (18) Comparative value of different roughened steel tension bars in large concrete beams. (19) Proper proportions of steel tension bars in concrete beams. (20) Adhesion of concrete to tension bars. (21) Resistances to shear in large concrete beams. (22) Strength of solid concrete beams under transverse stress. (23) Coefficients of elasticity of concrete for tension and compression. (24) Strength of steel I-beams encased in concrete. (25) Determination of best method of testing paving bricks.

F. In Hydraulics: (26) Water hammer in pipes. (27) Measurement of flow of water in pipes by use of Pitot tubes.

You will see that most of these experiments relate to problems of great interest to architects and engineers at this time.

We earnestly request all the members of this Society, and also those belonging to other engineering societies, to suggest problems for investigation, which will receive careful consideration by the Board of Direction. It is the chief aim of this Board to form and maintain intimate relations with all engineering interests and to labor for their benefit and advancement wherever possible. The success of the Engineering Experiment Station will largely depend upon the good will and assistance of the engineers practicing in Illinois.

PRESIDENT'S ANNUAL ADDRESS.

BY JOHN W. ALVORD.

It was my misfortune four years ago, at the last visit the Society made to Champaign, to become so lost to a sense of propriety as to attempt to ridicule the ancient custom of listening to the annual address of the President. I even went so far as to suggest that "Harnessing the Forces of Nature to the Uses of Men" was a rather overworked and hackneyed theme for these occasions, and I intimated with a somewhat pitiable attempt at sarcasm that there were at times highflown attempts to gather the credit of the world's progress for the year beneath the rather scanty mantle enfolding our profession.

Gentlemen, the lightning bolts of retribution have fallen. A few weeks ago it dawned on me that I, too, was scheduled to deliver a brilliant panegyric upon the annual advancement of engineering in its conquering career, and the embarrassment increased as I realized that, not only must I follow humbly in the wake of a long line of able and eloquent presidents, but must emulate addresses which have richly endowed our Society's literature, and annually filled our hearts with pride and joy. Having confessed to past irreverence, doubtless to the keen delight of our past presidents, I can conceive of no other and better amends than to boldly adopt the unjustly belittled title of four years ago and inflict upon you some fragmentary reflections on the art of "Harnessing the Forces of Nature to the Uses of Man."

Far back in the vistas of my memory, my father owned a large raw-boned, but usually well-disposed, bay mare, who went by the name of Betty, and whose duty it was to haul the family chariot up and down the long hill that lay between our house and the town. In return for these labors, Betty confidently expected and duly received three messes of oats, appropriate hay, a straw bed, and certain other emoluments and privileges daily, which she learned to know and exact with due regard for contract obligations and personal dignity.

At an early date in my career, and doubtless with a view of instilling the general principles of subjugating nature to the wants of man, my father appointed me Chief Engineer of the barnyard, especially charged with the duty of caring for and harnessing Betty night and morning. Now, as Betty stood full 16 hands high and my altitude recorded on the sitting room door for that year was but 46 inches, it may be imagined that the task was herculean in its difficulties and dangers. I have been engaged in the business of harnessing up nature for a good many years since that time, but may truly say that never have I had a job at once so disproportionate and so embarrassing. It was necessary, to begin with, to carefully note Betty's attitude of mind.

Nature has her varying moods, and so did Betty. Not that she was particularly obstreperous at any time, but she had a reflective mind, and was in the habit of reasoning from cause to effect. It was desirable not only to measure out the oats with a liberal hand, but to allow ample period for digestion before proceeding with the serious business of the day.

But among many other minor problems in the task of harnessing Betty was the chief difficulty of the installation of the bridle. Being entirely too short to deal with the important matter in the ordinary way, careful engineering study developed, from the necessities of the case, the plan of mounting to the edge of the oat bin, where with bridle in one hand and carefully balanced in mid-air, I would cautiously remove the halter with the other, and while addressing soothing words of persuasion, hold out the bit in an alluring manner, hoping against hope that she would yield promptly to its introduction between her teeth. It was a trying moment and generally resulted in failure. Betty had the proper idea that to allow a little lad too much success would be inconsistent with her dignity and my proper education, and being for the moment entirely free, she generally took occasion to turn her head in a contrary direction and look out of the stable door with prolonged and mischievous interest. I was therefore left anxiously holding out the bridle with both hands, swaying to and fro, but bravely ejaculating, "Whoa, Whoa, nice old Betty, Whoa!"

In subjugating the forces of Nature to the uses of man the ambitious engineer encounters many nerve-racking moments such as these. There are the trying periods in the construction of his work, when it is borne in on him that his preliminary surveys and plans have not developed all the facts in the case and large extras must be faced. There are other disagreeable moments when an elaborate plan is based on surveys that do not fit together, and the discrepancy is discovered all too late. At times, bids that have been received after much care are found to be radically different from the preliminary estimate. These ineffective attempts to get the bit into Nature's teeth are often the result of lack of stature and immature ability, and are, I regret to say, not altogether confined to the youth of our profession. The inevitable result to sensitive minds is either a helpless anxiety as to what Nature will do next, or humiliating moments when one is swayed to and fro by the peril of the situation, and there seems to be nothing to do but cry as bravely as possible, "Whoa, Whoa, nice old Betty, Whoa!"

I have alluded to the daily work of old Betty in hauling the family conveyance up the hill in front of our house. This was a serious undertaking and one which Betty rightly regarded as the supreme test of her endurance. The rise was rapid and the hill long, and on a hot summer day, with the sun in good working order, and a well filled carriage, nothing short of the oat bin at the journey's end, mingled with a light application of the whip, would have persuaded any ordinary horse to have exerted the necessary foot-pounds or work in the proper space of time. Betty's conduct showed her superiority and integrity. She was always allowed her own time, and on this hill had never felt the touch of the whip. Her method of approach to the task was scientific and rational. At a distance of probably 25 rods from the foot of the rise her rolling gait became a perfunctory trot, and from a trot fell to a leisurely walk, and with true engineering instinct she took advantage of a considerable level space to cool her blood, find her wind, and conserve her energies for the long ascent. Once well on the hill her back settled and her lank form grappled down to its work. The long sinews stood out in her legs, and in due course of time dark spots appeared beneath the harness, and flecks of white lather began to gather on her flanks. It was a magnificent spectacle of Nature well harnessed and down to her work. The spectators were sympathetic and Betty felt their appreciation. I have said that Betty was a usually gentle and well-disposed animal. Nevertheless, there were times when real injuries to her bill of rights moved her to passionate retaliation. I had not been long concentrating my attention on Betty's methods when I observed what I considered a serious mathematical mistake on her part. The approach to the hill and the speed adopted on its slope were always the same, regardless of the load. The empty carriage which I conducted home every morning was made to ascend the hill at the same rate as the crowded vehicle returning from church on a Sunday noon.

I determined early, and without seeking expert engineering advice, that this was wrong, and that Betty should see clearly by practical example that a light load meant higher speed according to all technical authorities. Therefore, the next time I was alone and she began to slow down on approaching the hill she felt the flick of the whip on her haunches and lurched forward with the unexpected sensation. Her next move was to stop full in the road and deliberately look around to see if I was in my right mind, and when she started again her ears tilted back in a way which should have warned me of trouble had I had a larger experience in the harnessing of Nature. On starting the ascent, however, another flick of the whip told Betty that the speed expressed in foot-pounds was insufficient, and two ears laid horizontally backward indicated that outraged dignity had reached its limit. With the third flick of the whip Betty suddenly stopped and deliberately kicked a hole through the dashboard.

Since this early experience I have come to watch closely when I have detected Nature overloaded. I recall, for instance, quite recently seeing a young and healthy creek in this State, which had broken through its bands, cut across a narrow neck and left the water supply for a city of 4,000 people high and dry half a mile away, all because a 10 foot dam had been built where a dam two feet in height would have been as much harness as Nature could stand. And Nature, much after the fashion of old Betty, simply reared up and kicked a hole for herself in another direction.

We have been interested of late in an epidemic of typhoid in Pennsylvania, remarkable for its proportions to the population affected. It would appear that surface supplies were suitably filtered, but necessary repairs caused the filters to be shut down for a week. Immediately contamination from an unsuspected typhoid case on the watershed started a violent epidemic of unusual proportions and it would seem that the right kind of a combination for an overload of Nature's laws had been followed swiftly and surely by Nature's revolt. The story of the Iroquois Theater fire is still fresh in our minds. Only a few moments after the City Inspector had made a perfunctory round, and within sight of the framed certificate of the Fire Marshal of Chicago saying all was safe, a spark flashed up into the scenery loft, burst into a furnace of flame, and finding all ventilators barred off over the stage, accumulated therein a vast volume of gas and heat until the opening of the stage door by the panic-stricken actors rolled the wave of death into the auditorium filled with a shrieking, struggling mass of humanity and stilled the cries of 600 human beings forever. In a modern, up-to-date, and fireproof theater, the combination of closed ventilators, a curtain which failed to act at the critical moment, and barred exits, overloaded Nature and brought terrible retribution.

We are too apt to draw the commonplace conclusion from these things, that someone terribly blundered, and we cannot always avoid the virtuous conclusion that we ourselves might have exercised more care and skill. Let us not jump to hasty conclusions. There is evidently a gap between our mathematics of experience and the special combination of circumstances that at times breaks down the scheme of defense. I am not especially versed in bridge work, but they tell me that many bridges are doing service that ought by rights to have fallen down years ago, while others correctly designed have been demolished by unforeseen circumstances. My theory of old Betty's speed varying with her load seems to be mathematically correct as I see it to-day, but somehow it did not work out in quite the way expected.

Here, then, is an element in dealing with the forces of Nature that must not be overlooked. It might be called the "crucial combination." That is to say, it is that especially fatal combination of circumstances, which, although of rare occurrence, is nevertheless always a possibility, and which must be guarded against in the proportions which experience shows to be necessary. It occurred at the Johnstown flood, at Ashtabula, on the Tay Bridge, at Butler, Pa., and at the Iroquois. It may never occur to you and me, and it may overwhelm us to-morrow. Let us therefore be more strenuous personally to avert its dangers by all that experience can teach us, but nevertheless charitable and considerate in judging others.

Betty's stall opened into a small yard which overlooked our garden. Often when allowed the privileges of the yard, she had gazed through the paling at the choice cropping that might be had in that carefully guarded plat and whinneyed pathetically at the waste of such good greens. The garden in question had afforded me many a weary hour. I had hoed the potatoes when I could hear the distant shouts of the boys at baseball. I had trellised the tomato vines when the neighborhood clan was in swimming, and had even desecrated Saturday afternoon picking peas and pruning the hawthorn hedge.

The personal labor which had thus ground into my soul nevertheless left me exceedingly watchful to protect the work which had cost so much sacrifice, and when one day returning from school, I espied Betty's tall form in the peas, and knew the open gate had at last given her the chance she desired, I rushed to the protection of my industry. Swinging my school books by the long strap, I seized Betty's tail and whacked her flanks with considerable force. Her tactics were entirely framed to gain time for the spoils. She moved in circles, snatching a mouthful here and there and apparently disregarding my punishment, and quite oblivious to the gateway to which she knew all my energy was directed.

The pace she set was so rapid that I was soon forced to hold on for self protection, where I had begun for punishment. Round and round we circled, faster and faster, so that all my attention soon became obsorbed in keeping my footing. We crashed through the tomato frame where I perforce left my hat and books; scraped along the grape arbor which blinded me and tore my coat. An instant later a young pear tree emerged from under Betty's legs and smote me heavily in the face, and finally tripped by a squash vine, I was dragged several yards through the mud and lost my hold and consciousness about the same time. When I was brought to myself by the united ministrations of the household assisted by the pump, they asked me "Why I did not let go," a question I was not then nor since able to answer satisfactorily.

Several times since those early days, I have found myself holding on to Nature's tail, in a frantic attempt to stop a wreck, and have afterwards regretted that I did not grapple with the problem in a more orderly and scientific manner. In emergency undertakings it is desirable not to be too rash. A little reflection on a plan is time well spent. Again, how often do we see men undertake responsible work in which they have had little or no previous experience. They must believe, with strange overconfidence, that they have an unusual intuition which will make experience unnecessary. This kind of optimism does not deliberately intend to gain experience at the expense of others, but such are the results in almost every case.

Impatience is a common failure in the engineering profession, as it is elsewhere. The rapid increase of national wealth in recent years has produced on all sides a large discontent with patience, and many of us are not content with the painstaking methods and well graduated steps which lead up to ripe experience. As a result, most of us have seen examples where the wrong man got hold of Nature by the tail and held on for reasons he could never afterwards satisfactorily explain.

Finally, I would point out that it is a wise engineer who knows how to get hold of Nature at the right end. Much agony of mind and wasted energy would be saved if this important truth could be borne in upon us early by some such practical example as I have related. One of the most important ways to get hold of Nature by the right end is to learn the fundamental principle, that the engineer's first duty is the thoughtful, careful and efficient work which will be a credit both to himself and his profession.

This must fill his mind before the question of emolument. To make money for himself is not the first business of the engineer. It is only a necessary incident. No man can properly fill the highest positions of trust such as come to our profession, when his mind is full of selfish interests, and when an engineer starts out to make money as a first consideration, and do engineering incidentally, he thoughtlessly gets hold of Nature at the wrong end, and usually destroys a great deal of good garden, with very little gain to himself in his struggles to hold on.

MUNICIPALLY OWNED WATER, GAS AND ELECTRIC LIGHT PLANTS.

BY F. E. HERDMAN.

(SUPERINTENDENT OF PUBLIC WORKS, WINNETKA, ILL.)

Why should there be any distinction between municipally owned water, gas and light plants and similar plants owned by private individuals? The mechanical questions involved in both cases are the same and the financial questions and management should be the same. I say should be the same, for unfortunately in many cases they are not; and that fact, and also the fact that the corrupt influences of money interests have triumphed over the needs of the people in preventing needed legislation, makes the discussion of municipally owned plants a separate subject from privately owned plants. The distinction being the financial and legislative or political side, I will devote my time to showing the difficulties in the way of municipal plants; what should be expected of our legislature, and what can be done.

It is a fact that in this great country founded on the principle of a government for the people and by the people, there are many municipalities not deserving of self-government, because the people do not take that interest in their municipal affairs which as loyal citizens they should. If a man invests money in a private corporation he immediately takes great interest in it from selfish motives; why should he not do the same with the municipality where he lives, for the same reason if not others? Here he is constantly investing money and why should not those investments be watched with the same care as a private corporation? A municipality should be considered and operated the same as a private corporation, the only difference being that all its citizens are the stockholders, each having a vote of which he cannot be deprived.

I believe that the people are beginning to more fully recognize these conditions with a corresponding improvement in municipal affairs; and hope that in the near future it will be to such an extent that the only distinction which will be made between municipal plants owned and operated by private capital and those owned and operated by a municipality will be that in the latter case all the people are profiting by them, instead of only a few. When our citizens will take this interest in municipal affairs, what a satisfaction it will be to the engineer in charge to know that he can handle the plants fearlessly on the basis of business, instead of being hampered by graft and favoritism; and what a great benefit the people themselves will reap from it. Legislation is needed. Provision is made by our Legislature for the financing and operation of municipal water plants, but where a municipality attempts the installation of a light or fuel plant for commercial purposes it discovers that it has a hard nut to crack and very poor teeth with which to do it.

A description of how we maneuvered the installation of our electric lighting plant at Winnetka, Ill., and how we expect to maneuver our fuel gas plant will better show how negligent our Legislature has been to provide the necessary needs for our municipalities. I say "necessary needs"; for what is for the general good of a community becomes a necessary need.

Our water plant was installed in 1893 in accordance with the Water Works Act, and paid for by special assessment. After it had been in operation about five years the question of light came up; but it was not until January, 1900, that we succeeded in getting our municipal lighting plant into operation, and during that time the Northwestern Gas Light & Coke Co. applied twice for a franchise, which the people almost unanimously refused.

Our main stumbling block was how to finance the undertaking. We absolutely had no State legislation to assist or even encourage us. The one way which had been tried elsewhere to accomplish the purpose was the formation of a company of a few citizens. The municipality then granted a franchise to this company and entered into a contract with it for street lighting—this contract to be of sufficient amount to pay the interest and liquidate the indebtedness incurred. This franchise and conract was then put up as security for the necessary loan to install the plant. The franchise, contract and bonds were put into the hands of a trustee, and the municipality paid into the hands of this trustee the amounts due on the contract from time to time. These amounts were applied on the interest and principal until the same were all paid off, when the franchise and all other papers were surrendered to the municipality. By agreement the municipality operated the plant. This method has its objections, and besides being complicated is much more costly in the first investment due to the heavy discounting of such papers. However, until the installation of our plant I believe it was the only method pursued.

Wishing to make our plant from the start a municipal plant, we devised the following plan: Our charter gave us the right to light our streets, though it provided no method of creating an indebtedness for the purpose. With this very incomplete authority we contracted for and installed our electric light plant, which represents an investment to date of $40,000. About $8,000 cash was taken from the general fund, and a franchise granted to the Chicago Telephone Co. netted an equivalent of $8,000. The remainder was paid in time warrants or later from the revenues of the plant. The contracts required the contractor to accept time warrants on the general fund, but previous arrangements were made with banks to cash these warrants at par, thereby permitting us to get cash prices for all machinery. The peculiarity of this transaction was that the time warrants were made out directly to the contractor and were received by him in direct exchange for his goods.

The plant was installed strictly under the head of a street lighting plant, to prevent legal complications. Having it installed, the village had undisputed right to sell the surplus light, provided no one was damaged by so doing. As the village had given no right to any individuals or corporations to manufacture and sell light, there was no opportunity for damages from that source. As the tax-payer was benefited he had no cause for interference. Therefore by a careful maneuvering the village has been able to own absolutely a municipal lighting plant, whose revenue has already grown to $12,000 a year and is still growing.

We are now planning for a municipal fuel gas plant. This requires similar maneuvering, in some ways more difficult and in other ways easier. Having provided street lighting we have not that excuse; besides our aim is cheap fuel and not light. To create the need for such a plant we will install it primarily for furnishing fuel to our present water and electric light plants, and substitute gas engines for the present steam engines and pumps.

On the basis of a fuel plant for our water plant we have ample authority for legally raising the necessary funds, and in this way an easier proposition to finance than the electric light plant. As the most practical location in our village for a gas plant is the southern limits of the village and the power plant is near the north end, a main artery is also provided through the center of the village. Granting that from an engineering standpoint this distance between power plant and gas plant is not the best, it must be remembered that in such problems there are always other factors of weight. With the fuel gas plant in operation we have, as in our light plant, a perfect right to sell our surplus fuel.

Our water and light plants are combined in one power house on the beach at the foot of the bluffs, 80 ft. high. Soft coal screenings are used, which are dumped into a chute connected with a bin at the foot of the bluff. Under the roof of the power house is a 5-ton bin which feeds directly into the hoppers in front of the furnaces. Under-feed mechanical stokers are used with such good results that for four years we have, while using soft coal, fully complied with a contract between the village and property owners to use hard coal or other fuel producing no more smoke. Our water is pumped to an elevation of 200 ft. above the lake into a tank of 50,000 gallons capacity, giving a pressure of from 50 to 70 lbs. throughout our village, depending on the elevation. The indicated pumpage is about 80,000,000 gallons per year, with a slippage averaging 5%, or an actual pumpage of about 76,000,000 gallons. This costs, allowing for depreciation, from 5 to 5½ cts. per 1,000 gallons to put into the mains.

There are 19 miles of mains. The loss by leakage, fires, etc., is 40% of the actual pumpage. All other water consumed is metered. The village has water for fires, street sprinkling, fountains and public buildings, without charge to the general fund. This places the entire expense of the plant on the private consumption, which makes the cost per 1,000 gallons of private consumption about 10 cts. The village has but one water rate: 15 cts. per 1,000 gallons, the minimum charge being $1 per quarter. The water fund has now a constantly increasing surplus besides paying for its own improvements.

The addition of the electric light plant was a great help to the water plant as many expenses could be shared. Our electric light is supplied from two alternating, 60-cycle, 2200-volt, generators, delivering to one switchboard from which run three street circuits and two commercial circuits. There are 207 series incandescent lights of 65-candle-power. The current used on the circuit is about 21 amperes. The maximum current on the commercial circuit is 27 amperes, making a total of 48 amperes or 105 K. W. at one time. The commercial is an all-night service. Everything is metered, including street circuits, and the cost of delivering the current at the switchboard is about 1.6 cts. per K. W. hour, and over the circuits from 2.3 cts. to 3 cts.

The general fund pays into the electric light fund $9 per year for each 65-candle-power street light, which you will recognize as an exceedingly low price; in fact, barely cost. The commercial light is sold at a rate of 15 cts. per 1,000 watts, and there is no minimum charge. The electric light plant has done well. It has been in operation just four years, and represents a cash investment of $40,000. Of this, the general fund paid $8,000, the franchise with the Chicago Telephone Co. yielded the equivalent of $8,000. There is an indebtedness of $10,000, and the remainder $14,000 has been paid out of the profits of the plant over and above the running expenses; but at present there is no surplus. From these figures you can judge what we will be able to do as soon as the remaining indebtedness is paid.

The installation of the fuel gas plant will require an investment of from $50,000 to $60,000. The saving in fuel at the power house by the use of the gas engine will be sufficient to pay a good interest on the cost of the change, and thus warranting it. But the great advantage in its use there, in addition to the question of financing, will be the increased output of the gas plant, as the power plant will consume at least 1,000,000 cu. ft. per month. And volume is the very important factor of a gas plant. We expect by the proper handling of the by-products to put gas into the holder at a cost of not to exceed 15 cts. per 1,000, with a corresponding decrease as the volume of consumption increases. We would commence with a rate of 75 cts. per 1,000 cu. ft., but having in mind a future rate of less than 50 cts.

The three plants can operate to the mutual benefit of each other and if the gas plant meets with the success we have had with our water and light plants we will have cause to be satisfied. What I have said will give some idea of what can be done in the way of municipal ownership of water, light and fuel plants; of the difficulties to be met with, and a line of legislation to which the State Legislature will give some attention if it wishes to care for the interests of the people.

There can be no question that if the people of this great nation have the intelligence and ability to create and operate this national government for the people and by the people then a community of a small portion of the same people of the same average intelligence and ability as the whole is capable of operating a municipal utility plant or plants which are for the common good and use of the people of that community. A lack of legislation can only be due to pressure on our legislature to sacrifice the needs and good of the people for the selfish interests of a few, and I believe that the increased interest in municipal ownership of public utilities will force the necessary legislation and will also produce the desired improvement in the administration of our municipalities. Taxes put into municipal plants will be tangible assets, and as such will more directly appeal to the people and create that interest and publicity which is the soil from which grows good and efficient government.

DISCUSSION.

PRESIDENT ALVORD: This paper is an interesting presentation of what can be done by a municipality when it earnestly sets about it. I have had some occasion to know about the difficulties to be met in these municipal enterprises, which have been met here with great skill. A large part of the success of this Winnetka enterprise is due to Mr. Herdman, whose capabilities and technical education have materially assisted the village in bringing about these desirable results. I know of no other case at all like it, in this part of the country, where a village has deliberately and consistently provided itself with so many public utilities.

PROF. A. N. TALBOT: I visited the plant at Winnetka last summer, and found it to be a remarkable plant, almost ideal, and the arrangement for burning slack coal without making smoke is certainly very successful. Attention ought to be called particularly to this case; where a village has, without seemingly any specific authority of law, and without more than the ordinary financial opportunities, been able to install a plant and furnish electric light in a commercial way. Of course they were aided by their skill and shrewdness in getting payment from the telephone company for the right to let telephones into the village. At the time it was installed a city or village had no legal right to sell light to private consumers, but Winnetka went ahead and collected those rentals, knowing that the consumer would be cut off at the end of the month if payment was not made and the only loss to the village would be the revenue for the month.

As has been said, a large part of the success of this enterprise is due to Mr. Herdman's ability and attention. He was at the time President of the Village Board, and for the last two years has occupied the position of Superintendent of Public Works of the village, and gives part of each day to that work. The office, as carried on there, is quite different from anything elsewhere in this State. Mr. Herdman's experience and technical ability in his general engineering practice has enabled the village to do work that could not have been done under other conditions.

PRESIDENT ALVORD: This case shows the value of technical education in the smaller villages of our State. It is one of the hopes of the times that when we get a State full of technically trained young men who know how to do those things, and can point out the way to do them, that they will bring us to an ideal existence where the municipalities can be supplied with a great many more of the essentials and comforts of life as public utilities than they now possess.

PROF. BAKER: I have been waiting for somebody to say that Mr. Herdman received his technical education and training at the University of Illinois.

THE MUNICIPAL ELECTRIC LIGHT AND WATER WORKS OF PARIS.

BY D. H. SAWYER. (MEMBER.)

The Paris water works was established in 1878, when a small stream at the southern border of the city was banked up and a direct supply of water furnished through a small pumping plant. This supply soon became inadequate and resort was made to shallow driven wells. Eight of these were driven at a point ½-mile from the plant, whence the water flowed by gravity through tile to the small reservoir. This experiment also providing an inadequate supply, the only other available source lay in impounding the water of Sugar Creek, a small country stream 1½ miles north of the business district of the city. In 1895 it was decided to utilize this, and a 20-ft. concrete dam was built across the stream at a narrow point which formed a water basin of about 60 acres. Interest in the construction of the dam seems to have occupied all attention, for the reservoir bottom was neglected to the extent of simply cutting off the trees and heavy brush, allowing stumps and small vegetation to remain.

Owing to a disagreement in 1886 with the company then supplying the city with gas light, it was decided to establish a system of arc lighting, combining this with the water plant into one central station. The system installed was the Ft. Wayne-Jenney and comprised three dynamos supplying 83 open arcs at the time the change was made to the present system. The light plant was moved to the present location at the same time it became necessary to move the water works. The present station, consisting of engine room, boiler room and coal bunkers, is situated on the south bank of the reservoir, close to the site of the dam. The two boilers, of the fire-tube type, were made in Terre Haute, and have a rating of 150 H. P. each. They have been in continuous service for about 20 years, having been moved from the old station to their present location. The simple high-speed Ide engine is belt connected to a 125-lamp Brush dynamo. The service pump is a duplex triple-expansion Worthington, rated at 2,500,000 gallons per day. The Blake reserve pump has a rating of 1,000,000 gallons per day.

The main pump suctions are located in a well supplied with water by a series of drain tiles radiating out into the reservoir. Another suction drawing from the deep water back of the dam is sometimes used in summer when the water in the well becomes foul. The pump discharge passes into a 12-in. pipe which runs in a straight line through the center of the city to an elevated tower at the site of the former water works, a distance of 2¼ miles. Auxiliary apparatus comprises two wooden tanks for mixing and storing the boiler compound, and a feed water heater and water motor, belt connected to a 30-light dynamo for use in the building when the arcs are not on. A daily record of operation is kept on blank forms, comprising the coal consumed, water pumped and feed-water entering boilers, separated into day and night runs; also the time of starting and stopping lights on the two circuits, and the consequent number of lamp hours on each circuit. Coal is brought from the bunkers in small cars which run onto scales in the boiler room, where the weight and number of the cars is taken and recorded. Pumpage is calculated by displacement from the stroke counter, which is read at 5:30 a. m. and 5:30 p. m., these being the starting times of the day and night run. The plunger displacement is 48 gallons per stroke count but in the following data 45 gallons has been used as being more nearly what the actual pumpage is. A 2-in. Worthington meter records the boiler feed water.

The water distribution system comprises pipe as follows: 10,900 ft. of 12-in., 1,200 ft. of 8-in., 45,500 ft. of 6-in., 15,800 ft. of 4-in., and 1,800 ft. less than 4-in. Total, 75,200 ft., or 14.2 miles. The system is easily controlled by means of 60 valves which are covered with ordinary valve boxes on unpaved streets and with small brick chambers on paved streets, which gives ready access for repairs without disturbing the pavement. The hydrants, of two patterns, Mathews and Nelson, are 151 in number, this being 10.6 hydrants per mile of main. As the system is not of sufficient size to warrant employing men and keeping a supply of material on hand for making taps and repairs, a contract is entered into yearly with some local plumber to do this work. The leading items in the contract for making taps for this year are as follows: ¾-in. taps in mains, $1 each; excavating, 6 cts. per ft.; ¾-in. galvanized pipe, 8 cts. per ft.; ¾-in. lead pipe, 30 cts. per ft.; corporation and goose neck, $2.10 each; corporations, $1 each; service cocks, 80 cts. each; service boxes, 85 cts. each. Repairs necessary to be made are reported to this contractor who at once attends to them, charging a reasonable price therefor. A total of 933 taps have been made on the system, 779 of which are now in use, this being 56 taps per mile of main. New taps are made and pipe carried to the curb line with a service cock and box in advance of all paving, this item amounting to $1,100 in 1903. The charge for new services is $8 when galvanized pipe is used and $12 for lead. An elevated tank on a steel tower 111 ft. high, holding 106,000 gallons, supplies the pressure for the city, this being 55 lbs. in the business district. This tank is ordinarily filled four times during the day and twice during the night.

The current distribution for the arc lamps is in two circuits, termed the inner and outer, the former carrying 48 lamps and the latter 58. The circuits comprise 17 miles of No. 6 copper wire. The lamps are supported from poles across intersections, with the exception of 16 which are carried by four steel towers 125 ft. high. The lamps are all 2,000 candle power, General Electric, enclosed, 6.6 amperes, 72 volts, operating on a moonlight schedule. Trouble on the lines, repairs and extensions are in charge of the trimmer, who employs assistants when required.

Control of the water and light department is vested in a board of three aldermen, elected yearly by the City Council. This board has no stated times for meeting, but leaves the active management to the superintendent, and meets only when matters of importance are to be decided. The collecting of water rates is combined with that of trimming the arc lamps, and is in the hands of one man, who, besides performing these duties, has oversight of repairs of the water and light system. Day and night engineman and night fireman have charge of the station, the day engineman looking after repairs, while the last two simply operate the plant during their run. The board enters into a contract for certain supplies as follows: Southern Indiana coal, f. o. b. cars at Paris, $2.20 per ton; hauling coal from cars to station, 2½ miles approximately, 30 cts. per ton; engine oil, 22 cts., and cylinder oil 32 cts. per gallon; carbons, $26.50 per 1,000.

STATISTICS OF PARIS WATER WORKS DEPARTMENT, 1903.

REVENUE:			
Receipts from consumers.............			$6830.73
Making new taps..................			336.00
Total revenue			$7166.73
DISBURSEMENTS:			
Superintendence and collecting......		$720.00	
Pumping Station:			
Engineman and fireman............	$ 960.00		
Coal	2230.40		
Oil and other supplies.............	81.65		
Repairs...	148.20		
		3420.25	
Dist'b'tion system, services and rep'rs		2386.25	
			$6526.50
Interest on bonds..................			915.00
Total operating expenses			$7441.50
Water main extension.............		$5461.51	
Purchase of reservoir property		858.75	
			$6320.26
Grand total.....................			$13761.76

Coal consumed, lbs.	1,960,630.
Boiler pressure, lbs.	90
Water evaporated per lb. of coal, lbs.	5.8
Total water pumped, gallons	240,657,000
Average daily pumpage, gallons	659,000
Average daily pumpage, per capita, (pop. 8,000)	82
Head pumped against, feet	201
Million gallons lifted 1 foot	48,372
Duty of pump, foot-lbs. per 100 lbs. coal	21,000,000
Cost per 1,000 gallons pumped, cents.	3.09
Cost per million gallons lifted 1 foot, cents	7.1

STATISTICS OF PARIS ELECTRIC LIGHT DEPARTMENT, 1903.

Superintendence, trimming etc.	$460.00	
Station:		
Engineman and fireman	960.00	
Coal	1857.40	
Oil and other supplies	81.65	
Repairs	216.04	
Lighting circuits, supplies, repair and minor extensions	852.97	
Grand total		$4428.06

System: G. E., d. c., series enclosed arcs—

Lamps in circuit at present, inner circuit	48
Lamps in circuit at present, outer circuit	58
Total	106
Average number of lamps in circuit for year	103
Length of circuit, miles	17
Cost per lamp per year	$42.99
Cost per lamp per hour, cents	1.6

The water supplied the city, coming as it does from a small country stream, with no purification whatever, is never safe for drinking purposes and is only palatable during cold weather. It has a disagreeable, fishy taste in summer, and during a long hot season the odor is offensive, due in large part to the fact that the reservoir basin was never properly cleared. Aside from the pollution coming into the stream from the watershed, a cemetery on the south slope drains directly into the reservoir. In order to provide water safe and satisfactory for drinking purposes, it would seem without a careful study of the subject, that four things would be necessary: First, abandoning the use of the upper part of the reservoir where the water is very shallow, by building a levee along the natural channel of the stream. Second, cutting down the banks of the reservoir to give a minimum depth of at least 5 ft. Third, collecting the drainage of the cemetery by means of drains parallel with the reservoir, and discharging them below the dam. Fourth, providing some method of purification, probably mechanical filtration. By these means the capacity of the reservoir would not be decreased and the city would be given a wholesome water for all purposes.

With the exception of the boilers, the station is as efficient as might be expected of a plant under our conditions. The boilers are inefficient, as is readily seen from the item of evaporation; they are operated at low steam pressure for safety, and are so old as to require frequent repairs. This fault will be corrected within the next few months by replacing the old boilers with new ones of a water tube-type. The item of coal hauling has amounted to nearly $600 in the past year, which indicates a loss that might be corrected by building a switch from the railway half a mile away. The water distribution system and the light circuits have been extended piecemeal, but care has been used in doing this and their only requirements will be those incident to usual maintenance and extension.

From a study of the plant it would seem that the original plan was a wise one, that its subsequent development has been thoughtfully carried out, and in its present state it ranks well with those under similar conditions.

DISCUSSION.

THE PRESIDENT: It is very desirable and instructive to have records of this kind, with reference to the working conditions and expenses of plants of this character. They are of more importance than most of us realize for convenient and ready reference.

PROF. TALBOT: I would like to ask Mr. Kemp as to the cost and operation of the water works at Kewanee.

MR. KEMP: We have a deep well plant consisting of three wells running down into the St. Peter sandstone, two of which are giving efficient service at the present time. We have the Cooke and the Knowles deep well pumps, which we are expecting to replace soon with two new Luitwieler deep well pumps, one 15-in. and one 18-in. head. The wells are 1,480 ft. deep with 7-in. and 9-in. drop pipes. We lift the water about 200 feet and our coal expense amounts to 7 cts. per 1,000 gallons pumped. Our consumption is very small, averaging during the entire year from 210,000 to 220,000 gallons per day. Ours is not a very large system, there being about 600 consumers. We have an 8-in. meter on a by-pass on the 10-in. main supply pipe. The first three months following the installation showed 67.8% of the water pumped as re-metered to consumers. I then made a thorough examination of the meters and replaced about 30 which were not giving satisfaction in registering, and the next quarter it ran up to 71.2%. This percentage does not include the water supply of 18 flush tanks. These are regulated by monthly inspection, and the man in charge uses a stream of sufficient size to flush the tanks twice a day. By watching it very carefully, I can keep the amount necessary down to about 3% of the total amount pumped. This percentage does not include the water supplied to the public fountains.

MR. D. H. MAURY: What is your estimate of the amount of water used by your 18 automatic flush tanks?

MR. KEMP: About 3% or 4%, or from 6,000 to 8,000 gallons a day for twice flushing the 18 tanks, the capacity of which is about 300 gallons; flushing twice a day.

D. H. MAURY: So they actually use about three times what their rated capacity is, or what they are supposed to use?

MR. KEMP: Yes, I think they use just about what they are supposed to use.

MR. MAURY: Do you think they use 10,000 gallons a day?

MR. KEMP: I have not the figures, but I have figured it averaged about 3% of the daily consumption, which would be between 6,000 and 8,000 gallons.

MR. MAURY: If they can be kept down below four or five times their rated capacity it will be unusual. We had five of these flush tanks, and one used 6,000 gallons, two were turned off where the city did not know anything about it, and the other two averaged about 3,000 gallons each.

MR. KEMP: How often were these flush tanks examined?

MR. MAURY: They belonged to the city. They did not belong to us.

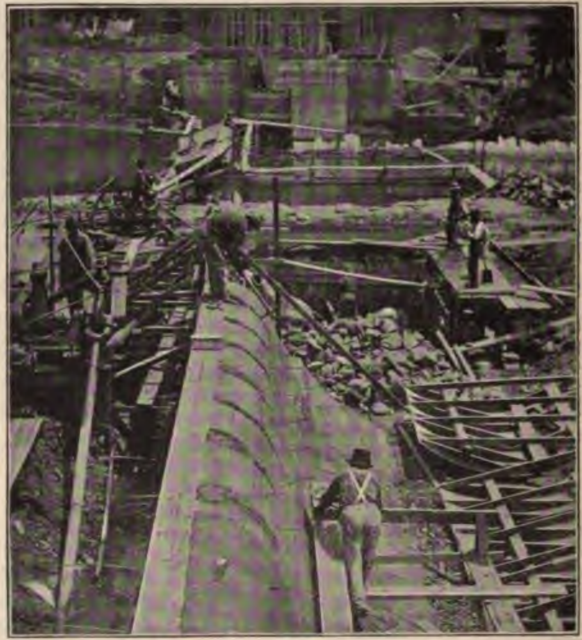
A MEMBER: We find it necessary to blow out the pipes occasionally to get efficient service.

PROF. TALBOT: This requires attention and supervision, given in the same way that care is given to the operation of parts of a water works plant. Because there has been negligence in some cases is not sufficient reason for condemning the matter as a whole, any more than it would be right to condemn a plant, some part of which has broken down because those in charge were negligent. It is not a very difficult matter to arrange an orifice, a very thin opening in the pipe, so that the flow will be somewhere near the amount desired for the 24 hours, varying somewhat of course with the length of service pipe connecting with the flush tank and with the pressure at different times during the day. In Champaign, for instance, such an arrangement is made, and I am told that with an inspection monthly, or oftener, they have very little trouble. Sometimes the flow is stopped materially, occasionally entirely, but by opening the second valve the service pipe is flushed out and the operation proceeds. But this implies inspection and care the same as for other features about a water works plant.

CONCRETE DAM AND WATER POWER PLANT AT DANVILLE ILL.

BY HOWARD M. ELY. (MEMBER.)

The dam to be considered was built at the Danville Water Co.'s plant just above the city, on the north bank of the Vermilion River.

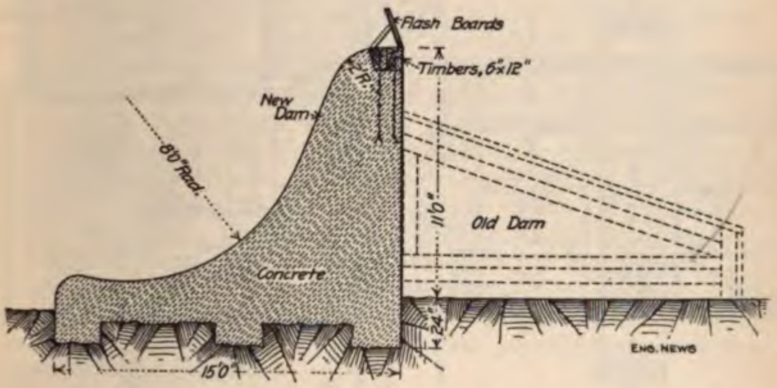


The company pumps from this stream to a mechanical filter plant which has just been built. The water was formerly impounded to form a basin over the intake pipe, by a timber dam 150 ft. in length. This timber dam has been replaced with a concrete dam, built against the downstream face of the former. The new dam is 13 ft. high, with an effective height of 11 ft., giving a head of 9 ft., which is utilized by a turbine.

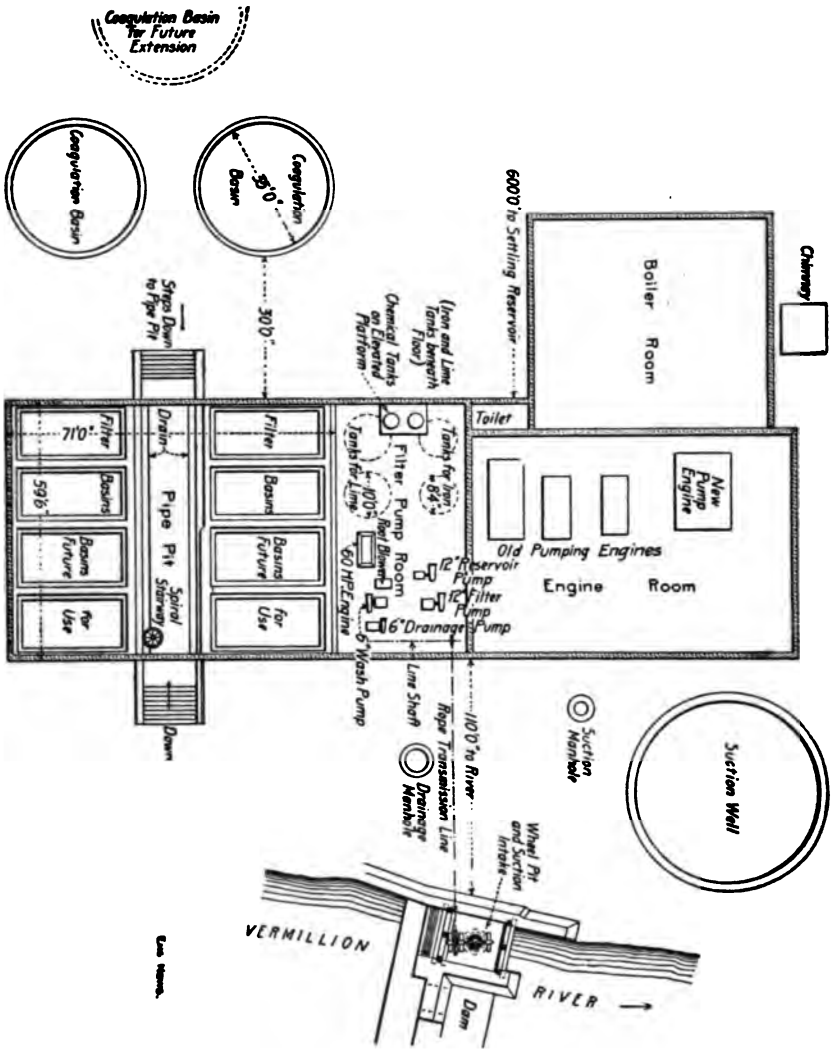
The crest of the dam is capped with timbers carrying standards to support flash boards. The rear of the crest has a curve 2 ft. radius, the down-stream face of the former. The new dam is 13 ft. high, width at base being 15 ft. The concrete is composed of 1 part Portland cement, 2½ parts sand and 5 parts 1½-in. crushed limestone. It was mixed in a Smith rotary mixer and made moderately wet. The cement was of the Owl brand, furnished by the German-American Portland Cement Co., of La Salle, Ill.

An interesting feature of this dam is the concrete fishway, allowing fish to make their way from the lower to the higher level. The fishway is formed in a series of steps of 18 in. drop, and these steps, instead of being horizontal longitudinally slope alternately in opposite directions, and are separated by plank partitions so as to form a zigzag channel. Across this channel are set inclined baffle boards, staggered so as to leave a circuitous passage and break up the current to such an extent as to allow the fish to easily swim against it in going up stream. To protect the fish while passing the fishway, a wooden grating is placed over it and secured with a padlock.

The dam is built upon a formation of carboniferous shale, found about 2 ft. below the river bed, and the excavation for foundation was carried about 2 ft. into the shale. The old dam was utilized as a cofferdam. The wheel-pit of the new dam was first built, and then the west abutment, while the river flowed through the middle of the dam. The dam was built in sections about 30 ft. long, each section being built in a cofferdam formed by the old dam and piles of sand bags, and kept dry by a centrifugal pump. The dam was built in three horizontal sections. On the foundation section the forms for the second or body section were erected, composed of hard pine flooring nailed to 2x8-in. uprights, with ¾-in. iron rods extending across the form. The form for the upper section had ribs cut to the radius of the convex curve of the crest, and upon these were nailed strips of flooring as the concrete was filled in, until the 6x12-in. timbers at the crest were reached. The grooves left by the ribs were afterwards filled with concrete, and the whole face of the dam was given a wash of neat cement. The length of the dam is 236 ft. and the spillway 98 ft.



The concrete of the three sections was bonded together in the horizontal joints by 8-in. strips of galvanized iron, 8 to 10 ft. long, set on edge and embedded to a depth of 4 in. in the concrete, leaving 4 in. exposed. The next day, the surface of the lower section would be carefully cleaned with a wire brush, given a coating of neat cement, and then the new concrete for the upper section was applied, the iron strips being thus embedded in both sections. Further bonding was



effected by forming grooves in the top of the concrete of the lower section. The vertical joints between the 30-ft. lengths were made in the same way, except that the strips of iron were embedded in the vertical grooves.

The dam was made of gravel concrete, but stone concrete was used for the wheel-pit. Gravel was obtained from the company's land, but most of it had to be hauled ¾-mile. Stone and cement had to be hauled 2 miles from the railway, which added 40 cts. per yd. to the cost of the stone, and 8 cts. per barrel to that of the cement. The concrete was made in proportions of 1 to 3 to 6, except that in the foundation a mixture of 1 to 2 to 4 was used. Hand mixed concrete was used for the wheel-pit, and machine mixed concrete for all the rest of the work. The average cost of the latter with a wheeling distance of 75 to 300 ft., was $3.90 per cu. yd. The dam was built by day labor. It contains 1,362 cu. yds. of concrete, including the retaining walls, and the average cost per cu. yd. of concrete was $4.35. The average cost per cu. yd. of dam, including excavation, pumping, forms, concrete, etc., was $9.40. The total cost was $13,635.

At the wheel-pit there are two gates, each operated by a rack and pinion, and serving to open or close the head race. About 10 ft. behind these is another pair of similar gates, behind which again is the turbine. Between the two sets of gates is the intake pipe, with an iron rack to catch driftwood. The gates are only lowered in case it is necessary to get access to the turbine or the intake. The power is developed by a 27-in. Victor turbine of 33 HP. at 302 revs. per min. with 8 ft. head; it was built by the Stilwell-Bierce & Smith-Vaile Co., of Dayton, O. Power is transmitted to a horizontal shaft by bevel gear, and on this shaft are rope pulleys driving pulleys on a shaft 18 ft. above, from which a 1½-in. manila rope transmission extends to the pump room of the filter house.

The dam was designed by Mr. Daniel W. Mead, consulting engineer, and the construction superintended by him and G. B. Sidelinger, Superintendent of the Danville Water Co., with the writer as resident engineer.

DISCUSSION.

MR. NICOLET: Were the forms included in the cost stated, or was any excavation included?

MR. ELY: The forms were included, but the excavation was not; that was merely for the concrete work. The gravel cost about 25 cts. per yd. We got our gravel from the land of the company and just paid for the hauling. Some of it was taken from the river bed.

THE WATER SUPPLY OF CHAMPAIGN AND URBANA, ILL.

BY F. C. AMSBARY (MANAGER, CHAMPAIGN & URBANA WATER CO.).

In the early '80's, several enterprising citizens of Champaign associated themselves into a coal mining company and commenced the sinking of a shaft. All went well until the contractor was forced to abandon work on account of an excess of water in the shaft. Some logical member of the company thought he saw an opportunity to get out of the hole as it were, and suggested a waterworks system, with the shaft as a source of supply. In the year 1885 the plant was built to supply Champaign, and a little later Urbana was connected. A vertical, duplex pumping engine was placed in the shaft, the steam ends above ground and the water ends down perhaps 80 ft., and for some time water was supplied in this manner, pumping direct into the mains. The cribbing of the shaft was poorly constructed, and the action of the pump (with its long piston rods) on an insecure foundation soon caused the cribbing to give way in places. After a hard fight of several years' duration the shaft supply was given up.

The next move was to establish tube wells, several were sunk to a depth of 160 ft. located inside the pump house, where a much superior supply both in quality and quantity was found. Cook deep well steam heads were installed, and a small storage reservoir constructed on the surface near the pump house to receive the discharge from the deep wells. A pressure pump erected inside the pump house took water from the basin outside and forced it directly into the distributing system. This plan was in operation several years, but the service was indifferent, owing to the frequent breaking down of the deep well pumps. The working barrels or cylinders of these pumps were swedged into the casing of the wells, and as the wells were not plumb, the result was that holes were worn through the casings, caused by the rods lashing. Considerable earth was admitted, causing the undermining of the building and pump foundations. The old abandoned shaft, located in the center of the pump room, had been filled with dirt, cinders, and some say straw, and added to the general uncertainty of the ground by continually settling. It was difficult to keep up the supply, and I am told that at times almost the only pressure that obtained about the pump house emanated from the Council Chamber at the City Hall.

In 1897, the company supplemented its pumping facilities by the installation of an air-lift outfit; four new wells were sunk outside the pump house, a cross-compound air-compressor was erected inside the building. This gave the company five Cook deep well pumps and four air-lift wells. The water consumption at that time was about

700,000 gallons per day, and very soon there was again trouble to keep up the supply. The air-lift wells delivered very little water, and the wells inside the pump house were out of service a good part of the time on account of repairs. It was found that the air-lift system was very expensive to operate, even more so (I am told) than the deep-well steam pumps, which you all know are about the limit.

In the fall of 1899 I made an inspection of the pumping station in the interest of prospective purchasers. I found a very discouraging condition. The basin was nearly empty, islands of sand protruded above the surface of the water, the pump room was carpeted with cinders and scrap iron, the whole place was dirty and neglected, and the walls of the pump house were out of plumb to such an extent that we did not feel safe within the building. I satisfied myself that the water supply was all right, also that Champaign and Urbana were good towns, and on the strength of this the purchase was recommended.

The first thing the writer did as manager was to brace up the brick walls of the pump house, then to secure a double-acting deep-well pump and place it over one of the air-lift wells. The results were very gratifying, as we were able to get upwards of 200,000 gallons of water per day out of this one well, with no apparent diminution in the flow of the other well nearby. This enabled us to shut down some of the inside wells and stop the damage they were doing to the building.

We purchased and installed four Downie double-acting deep-well power heads on the outside wells, entirely displacing the air-lift wells. A 100 H. P. Corliss engine was erected in the pump house, and a 50-K. W. direct-current generator was belted to the fly wheel of the engine, furnishing the power for four 10 H. P. motors, one for each of the deep well power heads. At the same time we erected a Gould triplex pressure pump of 1,500,000 gallons capacity and belted it to a pulley on the shaft of the Corliss engine. The shaft was made specially to admit of this. We installed a Wheeler surface condenser on the force main, receiving the exhaust of the Corliss engine. This plant has been in operation for over four years; it has been very successful and has saved us over $1,800 per year in fuel at $1 per ton in the shed. I should mention that the makers of the triplex pump did not like the idea of pumping direct into the mains with the pump driven by a Corliss engine whose speed must be constant, when it is well known that water consumption always varies. This difficulty we overcame by placing a Fisher governor on the steam pipe of the Worthington pump, which automatically starts when the output of the triplex falls below the consumption and maintains the pressure.

We installed a relief valve on the discharge of the triplex pump so that in the event of pressure running too high, the water would be discharged into the suction, but this device we have found by experience is not needed and it has been out of service for over a year.

When I state that we have about 80 flush tanks and a dozen watering troughs, running a constant stream at all times, you will see that we have a very good cushion to pump against. We have two pulley wheels on both the engine and the triplex pump in order to get a day speed and a night speed; a belt tightener enables us to shift the belt quite easily. It is intended to change these pulleys when the consumption of water increases to a point where this would be desirable. At the present time we are running this pump at about half its rated capacity.

With the old machinery it was necessary to run nine wells, and not sufficient water was obtained. With the present machinery, we are running five wells in the daytime and four at night; yet the basins are always running over in the morning, and this with an increase of 12% in consumption.

Three new wells were sunk during the past year in order that we might have a supply sufficient to carry on business in the event of something going wrong with either the Corliss engine or the generator. These wells are connected by belt and shafting to the Corliss engine, the belts and shaft being all in tunnels. We have an independent engine located in a building by itself with belt all ready and steam on so that it could be started up quickly. This engine will run the three new wells, which are equipped with Luitwieler "Triumph" pumping engines, or power heads, one of which you may see in operation at the waterworks of the University. We have two of our wells equipped with steam pumps, one double and one single. This will give us five wells that we could run with the generator or Corliss engine out of service. It is the intention to add more wells when they are needed, located so that they can be driven by the shaft now in service.

The writer is well aware that still greater economy in fuel could be obtained had the deep pit plan been adopted, using vertical pumps delivering water direct from the water-bearing sand to the mains, but the element of risk attending the construction of a suitable pit, and the great expense of installation, decided us against it. The small amount of water pumped, about 800,000 gallons per day, does not admit us into the high-duty class of pumping engines. In addition to the triplex pump we have two compound duplex pressure pumps with a combined capacity of 2,500,000 gallons. We have four horizontal tubular boilers, two of which are under fire at a time. They give us sufficient reserve to take care of fires.

The water bearing sand is found under a stratum of blue clay, perhaps 50 feet thick, which protects the supply from surface contamination. Analyses, both chemical and bacteriological, show the water to be of superior quality, and it is recommended by the experts of the University and the Board of Health, as being safe and wholesome.

As already mentioned, the water is delivered from the wells into the small basin. We enlarged this basin somewhat by building the walls higher. Three years ago we built an additional basin, circular in form, 100 ft. in diameter and 12 ft. deep, having a capacity of 750,000 gallons. This basin is of Portland cement concrete. The old basin is square, 60x60 ft., and 16 ft. deep in the center, the walls sloping towards the center. This basin has a capacity of 250,000 gallons, making a total storage capacity of 1,000,000 gallons. From the smaller basin the water is allowed to flow by gravity into the new basin by means of a flume, wide at the inlet and contracted at the outlet to connect with a 12 in. pipe which delivers the water into the new basin. This stream of water strikes the body of water in the new basin at an angle sufficient to keep the water in the reservoir in continual motion.

The discharge pipes of the several pumps into the small basin are so arranged that the water falls into the basin in a spray. The object of this arrangement is to give the water aeration which is beneficial (as we all know) where iron is held in solution in the natural water. We are able in this way to get considerable iron in the form of a precipitate from the larger basin while cleaning it, which we do four times a year. The larger basin has a bottom sloping to the center, at which point we have the drain pipe connected, and it is only the work of a few hours for one man to clean the basin with a hose.

The distributing system consists of about 24 miles of pipe from 10 ins. to 4 ins. diameter. In the two cities we have 236 fire hydrants, 126 gate valves, and 2,000 consumers. It is contemplated that two more miles of mains will be laid the coming season. A pressure of 45 lbs. is maintained at the pumps for domestic service and 100 lbs. for fires. We sometimes put 125 lbs. on for fires when more pressure is asked for. The first season after taking charge of the property we connected up 15 dead ends in the distributing system, with the usual good results, and few now exist.

We have in service 1,400 meters. Meters are required on all services where pipes extend into the house. Rates for water by meter measurement are 25 cents per 1,000 gallons for small consumers. We have no motors, except several used for pumping church organs.

DISCUSSION.

The President: What is the lift from the deep wells when they are running to their full capacity?

Mr. Amsbary: The wells are 160 ft. deep, and the water comes up within 60 ft. of the surface while the pumps are at rest. When the pumps are running at full capacity they lower the water about 40 ft.

THE HENNEPIN CANAL.

BY JAMES C. LONG (U. S. ASSISTANT ENGINEER, PRINCETON, ILL.)

This canal, officially known as the Ilinois and Mississippi Canal, is intended to be a link in a waterway from Lake Michigan at Chicago to a point on the Mississippi River at the mouth of Rock River, four miles below the city of Rock Island, Ill. It is being built by the United States, and is under the general charge of Captain C. S. Riche, Corps of Engineers, U. S. Army. The Feeder Line and Western Section are under the local charge of L. L. Wheeler, U. S. Assistant Engineer, and the Eastern Section is under the local charge of J. C. Long, U. S. Assistant Engineer.

The canal begins at the great bend of the Illinois River, 1¾ miles above the town of Hennepin, Ill., proceeding thence 62 miles, via Bureau Creek Valley and over the summit to Rock River at the mouth of Green River, near Colona, Ill., thence by slackwater down Rock River 8½ miles, thence by canal around the lower rapids of Rock River 4½ miles to the Mississippi River, making a total distance from the Illinois to the Mississippi River of 75 miles, and 193¼ miles from Chicago to the Mississippi River.

The canal is 80 ft. wide at water surface, 7 ft. deep, with lock chambers 170 ft. in length and 35 ft. in width, capable of passing barges of 600 tons burden. The summit level is about 11 miles in length, and the distance from its eastern end to the Illinois River is 18.4 miles, with a difference of level of 196.4 ft., which is overcome by 21 locks. The distance from the western end of the summit level to the Mississippi River is 45.6 miles and the difference in level of 100 ft. is overcome by 11 locks. The summit level is fed by a navigable feeder, which is of the same size as the main canal and 29 miles long, beginning near Sterling, Ill., where water for the feeder is obtained by damming Rock River. A lock is located at the head of the feeder, as a guard lock, also to enable boats to pass from the feeder into the river and back, at the different stages of the water in the river. The dam located here also creates slackwater in Rock River, enabling boats to navigate it as far as Dixon, Ill., giving that place, as well as Sterling, water connection with the canal.

Work was begun on the canal in July, 1892, on the Mississippi near the mouth of Rock River, and the 4½ miles of canal around the lower rapids of Rock River, with slackwater in the river above, was completed and formally opened to navigation, April 17, 1895, and since that time has been largely used by coal boats from the mines on Rock River. The feeder and the rest of the canal are still under construction and are about 75% completed. The original estimate of the cost of the whole improvement was in round numbers $7,000,000, but owing to various unavoidable causes it will cost something more.

The masonry in the large number of structures, such as locks, arch culverts, abutments and piers of railway, highway and aqueduct bridges, has all been constructed of concrete and has demonstrated its superiority over ordinary masonry, both in stability and economy of construction; also in rapidity of execution. The walls of 21 locks on the eastern section, containing on an average 2,500 cubic yards of concrete masonry each, were built in an average of ten days' time each, working 3 shifts of 8 hours per day.

As stated before, this canal is to be a link in a waterway from Chicago to the Mississippi River, near Rock Island. Another link is the Illinois and Michigan canal, belonging to the State of Illinois, extending from the Chicago River about 5 miles above its mouth, to La Salle. It is 96 miles long, 60 ft. wide at water surface, 36 ft. wide at bottom in earth excavation, and 48 ft. wide in rock, with locks 110 ft. long, 18 ft. wide, and having 6 ft. of water over the miter sills. It is navigable by boats 97 ft. long, 17 ft. 6 ins. wide and 5 ft. draft. It will be seen by these dimensions that the Hennepin canal cannot reach its usefulness until the State canal is enlarged, which it is supposed will be done by the United States after the Hennepin canal is completed, two years hence, by agreement with the State of Illinois.

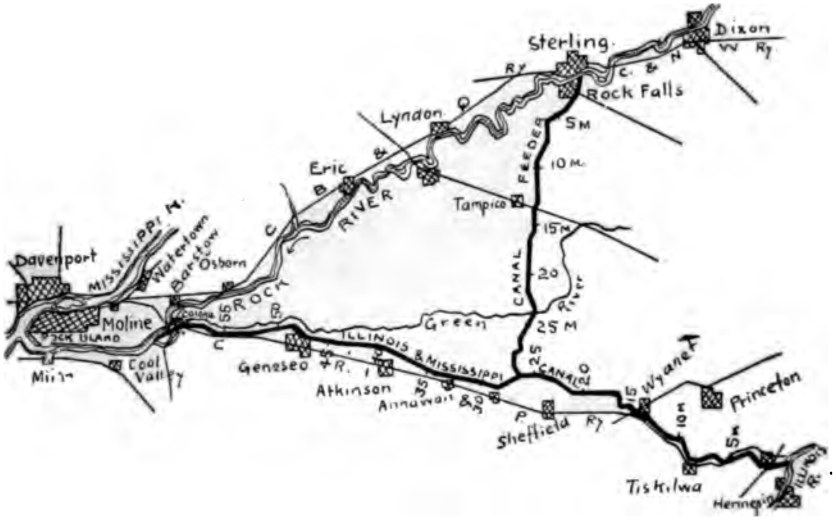
DISCUSSION.

MR. D. W. MEAD: I have recently had occasion to investigate some questions concerning the Illinois and Mississippi Canal, and the influence which feeding this canal will have on the water power of the Rock River at Sterling and Rock Falls, Ill. From this point the canal will be fed by a navigable feeder, which here taps the Rock River, and conducts the water to the summit level of the Illinois and Mississippi Canal, near Sheffield, Ill. The accompanying map was made to show the various relations of this canal and feeder and the Rock River, and will give a clear idea of the general location and relations of this canal.

The quantity of water which will be taken from the Rock River is of much importance to the power users below the mouth of the canal. The Rock River, like most of our western rivers, is extremely variable. Its drainage area above Sterling is about 8,900 sq. miles, and while it has a dry weather flow of only 600 to 700 cu. ft. per second, the extreme storm water flow is probably in the neighborhood of 40,000 cu. ft. per second. While the quantity of water which will be diverted from this stream is of no importance during storm periods and periods of high flow, it may become a very serious matter during periods of low flow, and the relative effect of the diversion will, of course, vary with the quantity of water so diverted. What this quantity will be is largely open to conjecture. The lowest estimate that has been made of the amount of water needed for feeding the Illinois and Mississippi

Canal is 180 cu. ft. per second, but I hardly think that any engineer who has examined this subject, now believes the quantity needed will be as low as that amount. Other estimates vary from 300 to 500 cu. ft. per second, with even greater demands on the river at the time at which the canal is to be filled. During the first year or two after the canal is put in service and until the bed and banks become thoroughly silted, it is expected that even a larger amount of water may be also used than the maximum estimate mentioned above. It will, therefore, be seen that at periods of extreme minimum flow the entire flow of the river may be needed for feeding the canal.

The great variation in conditions to which any estimate of this kind is subjected, may be understood from the fact that in the present Erie Canal, which has, within a few years been dredged and deepened, various sections on which measurements of seepage were made show losses varying from 6 or 8 ins. per day to as high as 18 or 19 ins. per day over the entire water surface. In many foreign canals, where great care is taken to make the beds tight by puddling and other means, the losses have been reduced as low as 2 ins. On account of the great cost of such work, no results of this sort are practicable in this country at present.



The relations of the mean monthly stream flow of the Rock River, as demonstrated by government gaugings at the United States dam, near Milan, Ill., and the U. S. rainfall records over the watershed, are shown in the following table, taken from the report previously mentioned:

RAINFALL ON WATERSHED OF ROCK RIVER (INCHES).

	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.
1895..				.90	.96	3.19	1.56	3.16	2.85	1.99	.64	2.33
1896..	2.23	.73	1.10	1.27	4.04	5.15	2.97	5.05	2.36	5.81	1.20	1.59
1897..	.70	3.01	1.08	3.16								

DISCHARGE OF THE ROCK RIVER AT MILAN DAM.

(Mean Monthly Discharge in Cubic Feet per Second.)

1895..				8800	3792	3375	1613	1775	1445	1794	1287	1613
1896..	2438	2010	4953	3647	3586	5141	3062	1785	2283	3103	2283	2540
1897..	1938	4760	4814	19665								

(Run-Off in Cubic Feet Per Second Per Square Mile.)

1895..				.765	.347	.310	.148	.183	.133	.165	.118	.148
1896..	.224	.105	.455	.334	.330	.473	.282	.184	.210	.286	.210	.234
1897..	.178	.438	.443	1.809								

(Run-Off Depth in Inches on Watershed.)

1895..				.88	.39	.36	.17	.21	.15	.18	.14	.17
1896..	.25	.21	.48	.38	.38	.54	.32	.21	.24	.33	.24	.26
1897..	.21	.51	.47	2.09								

(Run-Off in Percentage of Rainfall.)

1895..				.98	.41	11.3	11.1	6.7	5.3	9.1	21.9	7.3
1896..	11.2	28.8	43.6	.30	9.4	10.5	10.8	4.2	10.2	5.8	20 0	16.3
1897..	30.	16.9	43.5	.66								

FLOODS AND FLOOD PROTECTION WORKS AT EAST ST. LOUIS.

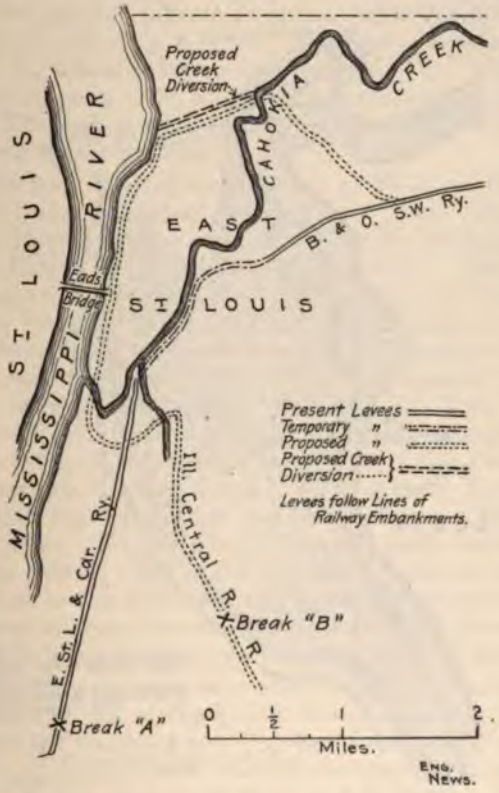
BY JAMES F. PARR. (MEMBER.)

East St. Louis and the neighboring towns of Brooklyn, Venice, Madison and Granite City (on the north), comprising a population of some 50,000 or 60,000, are situated on the east side of the Mississippi River in the "American Bottoms," opposite to the city of St. Louis, Mo. The Mississippi, with its great tributary, the Missouri, rising in the Rocky Mountains, and its smaller tributaries, the Illinois, Des Moines, Kansas or Kaw Rivers, carry past the city an immense volume of water every year. The snows of the Rockies begin to melt in April and by June are beginning to flow by and give what is locally known as the June rise. This rise itself gives a fair stage of water, but does not endanger the American Bottoms. Should there be excessive rains in the head waters of these streams to add themselves to the June rise trouble may be looked for.

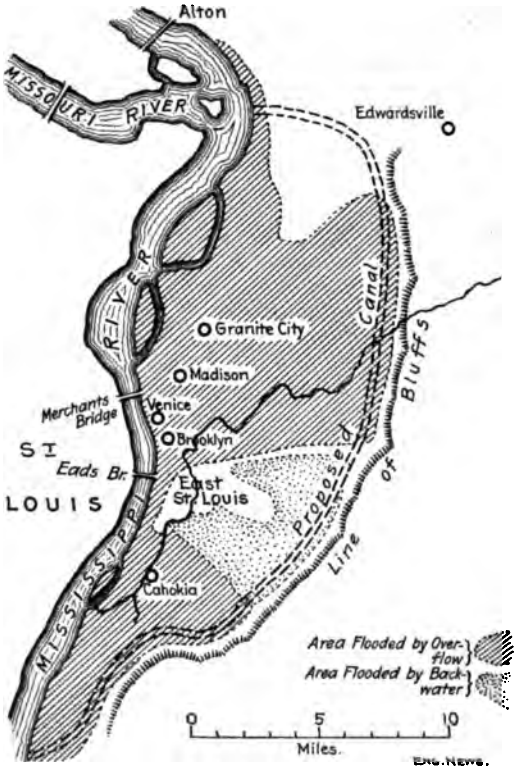
Beginning on May 20, 1903, and lasting for a period of 10 days, a series of storms passed over Kansas, Nebraska, Iowa, Minnesota, Wisconsin and northern Missouri and Illinois, flooding this territory and overflowing the banks of the creeks and rivers. The rainfall in a short time was, at Sioux City, 2.7 ins.; at Des Moines 2.18 ins.; at Davenport, 1.96 ins.; at Concordia, 1.74 ins.; at Peoria, 1.12 ins. This rain fell at such a time that by the time it reached the Missouri River it joined with the June rise and passed on down toward the Mississippi in time to there join the high waters coming from the north and all went by in a mighty rush for the Gulf of Mexico, causing destruction to life and property.

Fortunately for the people living south of us, the Ohio was at a low stage and this was also a fortunate thing for us, as there was no flooded river below to retard the waters here, as certainly would have been the case had the Ohio been full at the time. All along the river, levees that were considered protection failed. Railway embankments were like playthings to the waters. All through the American Bottoms are levees and cross levees and railway embankments built to hold these waters.

At East St. Louis, the B. & O. R. R. enters on the north, coming in from the bluffs some 6 or 7 miles east. It built its embankments above the highest water known, that of 1844. South of us, the farmers had built a levee and in course of time the Conlogue Ry. took possession of this levee and is keeping it up for the use of it. East St. Louis is divided by Cahokia Creek, and nearly the whole part west of the creek is occupied by railway yards and freight depots. That part east is the business and residence portion. On the creek is the station known as the Relay depot, from which the B. & O. Ry. levee leads out, and whose banks were a solid wall during the whole of the flood. This levee does not reach its full height until about ¼ mile northeast of the relay. From this high point south and by the relay and on south to the Conlogue, some ½ mile below the relay, there is a low levee some 4 ft. below the last high water. This stretch of ¾-mile is where the fight was hardest. On the south of town, and running to the bluffs, is the Illinois Central Ry., whose banks were a levee. Through the east part of town is a railroad track known as the Belt, which was used as a second levee.



As to high waters, there are unwritten records as far back as 1700. The effects of these past records are shown by the washings in the bottoms, where in a number of cases lakes are now left to mark their courses. These bottoms are from 3 to 6 and 8 miles wide in our vicinity. The first high water, of which we have only a small idea, was in 1785, and called by the Indians "Big Waters." Its elevations are said to have been marked by the Indians, who cut notches in the tree with their tomahawks, but I have never seen such a mark. From the Indians this is the highest water known. There was a high water in 1823, but as far as I know there is no record of its stage. In 1826 was a year of high water, when the stage reached 36.4 ft. We have no records of high water from then until 1844.



In the winter of 1843 and 1844, according to reports, there was a very heavy snowfall on the watershed of the whole of the upper Mississippi valley. This melting snow began to swell the rivers in April and by May it had covered the whole of the American Bottoms, there being no levees then. In a short time it began to fall and at the same time heavy rains to the north began. By the time the river was within its banks these rains began to pass by and on May 20 another stage higher than the first swept by. The river had just begun to fall when another rain storm passed over the north, and on June 23 it had reached a higher stage, and for five days stood high, reaching an elevation of 41.4 ft. on June 28. In this year the water receded very slowly. The next high water was in 1851, when on June 10 the gauge read 36.7 ft. In 1855, a reading was made of 37.1 ft. In 1858, on June 15, 37.1 ft. On April 26, 1862, 31.45 ft. It was not until May 10, 1876, that a stage of 32 ft. was reached. Then on May 6, 1881, 33.65 ft. On July 5 and 6, 1882, 32.2 ft. On June 26, 1883, 34.8 ft. On May 9, 1892, 36 ft.; this gave trouble, after which all levees were raised and strengthened. From that time until this the levees held; there being 31 ft. on May 3, 1893. The above elevations are above a stage of 30 ft., which is known as the danger line. The zero refers to a low-water stage in 1863, at which time there was a stage of some 10 or 12 ft. This zero gauge is equal to an elevation of 378.97 ft. above mean Gulf level at Biloxi, Miss.

The 1903 flood reached an elevation of 38 ft. in the evening of June 10, this being the highest recorded since 1844. While the gauge showed 38 ft.,there was an elevation of 40 ft. at the Relay depot, and 41 ft. a mile farther up on the north side of town. This is accounted for by the railway yards forming levees, and by the direction of the river, the city being on the back of the bend, or outside of the curve. Our main street from the residence and business part to the river and to St. Louis was above the highest water and formed a dam to the water. The railway embankment leading to the Eads Bridge, just above this street and just below Relay, assisted in keeping the stage higher, there being only the main river and Cahokia Creek to let the water pass through. In the short space of 700 ft. from the Relay, south along Cahokia Creek, there was a fall of over a foot in the current of the water. Nearly all the railway yards between Cahokia Creek and the river at right angles to the river, and as the water rose the one farthest to the north was the first to be submerged, and then in a short time all were broken through or else overflowed and what was supposed to be protection proved to be too low in the flood.

These yards are all made over what was once a secondary channel to the main river. All of these yard tracks cross Cahokia Creek on trestles, except the Vandalia and Terminal lines just below the Relay, which cross on plate girders on masonry abutments and somewhat narrowed up the creek. There was more or less drift in the creek and this added to blockade the passage of the water. As the water came over these yard tracks it caught a small house just above the Vandalia and Terminal girder opening and lodged it at this opening, which was probably the cause of the greater depth at the Relay and also the great fall mentioned.

As to the emergency methods used, it was at first intended to raise the embankments in these yards. but it was soon found that that would not do as the river was rising at a rate that would indicate submergency in a short time. That part of the town west of Cahokia

Creek was therefore abandoned, and preparations were begun to form a levee along Cahokia Creek by means of sacks filled with sand, gravel and clay placed along the points of danger. These sacks were laid at right angles to the water and the clay was thrown on the water side to prevent seepage. Then as the water rose a second row of sacks was placed inside of these, some two or three feet of space being left between the two rows. This space was then filled with clay and then a second layer of sacks was placed on the first row, and then more clay filled in. In the meantime the levee was kept above the rising water. Where possible the sand was used to fill sacks and clay reserved for intermediate filling. This levee was built on top of some of the yard tracks running parallel to the creek, and so close that dirt was plowed from the trains by means of a steam plow upon and over the sacks laid. This saved handling the material a second time. The train of sand stood on a track near the emergency levee and was kept full of men filling sacks, which were carried to the place needed. Nearly all of the yards were emptied along the temporary levee, so that they could be used for storing trains of sand, clay, etc., for raising the levee.

It was fortunate that the World's Fair was building, as the steam shovels used for leveling the hills there were kept busy loading dirt trains for the protection of East St. Louis, until the water got so high that trains could not be brought over by the Terminal Ry. They ran trains in from 3 ft. to 4 ft. of water and men had to use their feet to find the switch lever to thrown it. One train of dirt was wrecked on tracks 4 ft. under water, within 100 ft. of the point where needed, because of the inability to properly thrown the switch or to see that it was clear after being thrown. The Illinois Central Ry. ran trains to the bluffs, where men were kept busy loading dirt, which was used on the south end of the levee. The L. & N. Ry., whose yards were on the inside of and adjoining the levee, kept trains busy loading dirt and hauling from the bluffs. The roads entering from the north lent assistance until they were cut off by the water. The St. Louis, Belleville & Suburban Electric street railway lent valuable assistance after other roads were cut off, as well as before. After some of the roads were cut off from the bluffs, dirt was taken from the inside of the city limits and on private property. As fast as sacks were laid the earth was tramped by the continual passage of men carrying sacks forward to other places. In some places extra caution was necessary; sacks were laid at the foot of the railway embankments and carried up to the slope and then up with the rise of the water. This was found necessary because of the cinder filling used in the original raising of the side and main tracks. More caution was used at night than in the daytime from the fact that the torches carried showed the seeping of the water plainer, and I believe to some extent exaggerated the size of the seepage. I often noticed that where seepage was watched it did not exercise the minds of the watchers by day as strongly as it did by night.

The first break occurred some three miles below the city and began to fill that territory. Then the Illinois Central Ry. embankment became a secondary levee on the south and that was guarded until a break nearly at the last moment flooded the southern part as far as Broadway, which street (being elevated) formed another levee in conjunction with a track on the east side of town. This break occurred at an old filled spot. This back water on account of a break being below did not rise as high as the river by some 4 ft., and the majority of the town was left dry. After the water reached Broadway from the break it began to slowly work its way through it by means of the laterals to the sewer and later by a break in the Broadway sewer. By this time the river began to fall and the seepage through this street did not rise as high as the back water. Some of the cross streets in the business part of the town are made of sand from the river and when the seep water rose high enough it softened them and they went to pieces. They were built with a slope of 1½ to 1 and were paved with brick. As soon as possible after the river began to fall men were put to work opening outlets for the water to escape. All sewers had been stopped by filling them with sacks of sand to keep the water from backing in through them. It was a task far harder to remove these sacks than to place them in the manholes of the sewers, the sacks being often torn to pieces when being removed.

As East St. Louis has to pump the sewage in certain stages of the water in the river, and as two of the pumps were stationed where they became inoperative after the river rose, after the break it left the city with only one pump to remove the sewage and backwater. As soon as possible a fire engine from St. Louis and one from Belleville were obtained and water was pumped out by means of fire hose without nozzles. Our only pump was removed to a better location and water pipe borrowed from the water company was laid on top of the ground and the water pumped out in this manner over the top of the temporary levee. As the back-water was always lower than the river, as the river fell it was some time before the outlet sewers could be opened because of the danger of the water rushing in instead of out. Levels were taken every day, and as soon as the river fell below the elevation of the back water, all outlet sewers were opened and assisted the pumps in removing the back-water, the flooded pumps being put in operation as soon as possible. The breaks in the levees while flooding the lower part of the town did not carry the water out as fast as it came in and in time the river dropped below this back-water.

There are several methods suggested for the prevention of floods in the future. The one suggested which our member of the Legislature and others are working on is to build a levee at Alton, Ill., on the east bank of the river as far down as will be sufficient to protect the whole "American Bottom," including farmers as well as towns and cities. This proposition will necessitate flood gates at the outlet of all creeks, with pumping plants to be used in times of high water. On the whole I am inclined to think this the best plan. A plan was suggested previous to this flood, and has been suggested again, to change Cahokia Creek above the city and turn it into the river above and use the dirt excavated therefrom to make a levee on the south side of the creek. From where the creek is to be changed there cross two belt line railways, running parallel and 100 ft. apart from the creek to the B. & O. Ry. These are to be raised high above the water and the space betwen them to be filled in. If this is done it will give along the belt tracks a levee about 100 ft. wide on top. From their intersection with the B. & O. Ry. to the bluffs this railway is high enough, but it is suggested that it be strengthened. The Vandalia Ry. runs along the north side of and paralleled to the B. & O. Ry., and in the present high water it was under water. It has been suggested that the Vandalia be raised above high water and that the space between it and the B. & O. be filled in; if this is done it would give a solid levee on the north of 100 ft. wide from the river to the bluffs. It would necessitate a levee being raised several feet above any previous high water, as such a levee running almost at right angles to the river would form a dam, with the river as the only outlet. From where the proposed change of the creek empties into the river it is intended to raise Front St. (which runs parallel to and on the river bank), and the railways that occupy the river front between Front St. and the river, to a height above any possible overflow. This front levee to be carried south to the extreme southern part of the city, where the Southern yards are and then to follow this track to where it crosses the Illinois Central Ry., and then to follow this road to the bluffs on the south. A part of this proposed levee on the river front is in working condition now, but does not extend far enough north or south. The southern embankment on the south is partly high enough, as is part of the Illinois Central Ry. The latter, on the south, has two tracks running parallel and 100 ft. apart, which now form a good levee. It is suggested that these be raised and the space between them filled in. If these suggestions were carried out it would give East St. Louis an independent levee system.

Another proposition is to make a new channel for Cahokia Creek from where it leaves the bluffs, and to follow the bluffs far enough south so that no back-water would rise high enough to overflow the land. The earth excavated from this channel is to be thrown on the side opposite the bluffs to form a levee, and flood gates to be placed in this levee to prevent inflow from any back-water. This proposition would do away with the creek through or above East St. Louis and would turn any overflow of the river east of us.

Another plan is to excavate a canal from the junction of the Missouri with the Mississippi east to the bluffs and then along the bluffs south, and uniting with the Mississippi some 20 miles below East St. Louis. The excavation from this canal to form a levee on the south and west sides and to make an island of the present city of East St. Louis. The canal to be 200 ft. wide and deep enough to float barges. This canal would necessitate the raising of all railways at the bluffs, but as they now have to climb them it would only lengthen their distance of incline giving a better grade; or else place them higher up so that better advantage of the hills might be taken. The canal idea originated from the same principle used in some of the old countries where canals exist in river bottoms and where they are made beneficial to adjacent property. This levee might be used in a double way; as a public thoroughfare or boulevard, and for a belt line railway for transferring freight for through points on the various roads that cross it. The property adjacent to the levee might be used for manufacturing sites, as there is plenty of coal in the bluffs. It is claimed that this canal would so enhance the value of property benefited that no higher tax rate would be necessary.

A smaller proposition suggested, which includes only the residence portion, was voted on Dec. 15 and carried by a small majority. This proposition was considered by a great many not to be the proper method, as it left exposed nearly all railway yards which were giving employment to so many. As the law only allows assessment to be made on property benefited, they claimed that there would not be taxes enough raised to properly build such levee. A number who voted against the proposition would have voted for a proposition to levee the whole city. Out of a vote of over 7,000, not one-half voted. As this vote had to be ratified by two-thirds majority of the city council it has failed to pass, there not being a two-thirds vote of the council in favor of it.

The estimated loss has been placed at from $1,500,000 to $2,000,000 to railway property, city property, and the temporary throwing out of employment of men working in the different factories that were closed. The cost to the city in building this temporary levee has been placed at $70,000. The loss to railways was in overflowed tracks and washouts in yards and loss of business during the flood. The loss to the city was in the destroying of streets and pumping plants; and in the overflowed district citizens lost their household goods, and business houses lost goods in the basements. There was also a loss to business in general.

While it may seem strange, it is nevertheless a fact that the flood was to a certain extent a benefit. It washed and floated away a great amount of decaying matter thrown in alleys and open fields. One would suppose sickness would follow, but such was not the case, and has not been in any previous flood. One reason was that all was put in good order before being occupied again and there was no stagnant water left to breed any kind of disease.

DISCUSSION.

PROF. TALBOT: I had an opportunity to inspect the flooded district last summer, and no one can appreciate the conditions there unless he has seen the flood or its effects. As to the description of the work done on the temporary levee, one can hardly believe that men could accomplish what was accomplished there in so short a time. So far as the measures taken to prevent the recurrence of such floods are concerned, it seems to me that East St. Louis and the State of Illinois are interested in having something done which will be a permanent protection and make the situation such as it should be for so promising a district. St. Louis is a great city, a good business point. East St. Louis has the best location for manufacturing and for railway business of any point about St. Louis. This flat territory and cheap land on the east gives opportunity for future growth. The railways center there, and coal is plentiful. With St. Louis as a commercial center there is no reason why Illinois should not profit by the extension of business enterprises and increased population on the east side of the river to the number of 300,000 to 500,000 people in the next few years, provided proper steps are taken to protect this territory from floods.

The State of Illinois ought to be liberal in its legislation, and ought to make a careful study of the situation to determine what steps should be taken to make laws which will permit of carrying out the needed improvements. The formation of a levee district under local assessment methods, or on some such basis as the Sanitary District of Chicago, may be the best plan. Of course, the levee laws of the State have been made for agricultural purposes, and, in order to prevent money being wasted, the law permits only a certain small amount to be used for maintenance and a limited amount for construction. The assessment law is based upon valuation of farm land, and not upon benefits to city property or to railways. For these and other reasons the present laws are not applicable to the situation.

I have heard of the proposal to construct a ditch directly to the river. The objection of the commissioners of the levee district immediately north of East St. Louis, including Venice and Madison, to this plan, is that it would make the situation in their territory very much worse than at present, since the back-water coming up the creek would come from a point in the Mississippi some distance north of the present mouth of Cahokia Creek, and therefore, by reason of the large drop in level which has been mentioned, due to the river being narrowed down at the Eads bridge and immediately above it, the level of the back-water would be raised several feet, overcoming any levees which they have at present, or which they might expect to make in the future. Either of the other plans proposed and shown on the map, making a levee from Alton down to protect the whole territory, or the canal, may be feasible. A plan should be selected which would favor the growth of East St. Louis to a large industrial city. The interests of East St. Louis and its vicinity, and of St. Louis, would be conserved in making a great effort to secure the permanent improvement of this whole territory, and not something temporary and for a small portion of the territory, and for only small floods.

MR. PARR: There are three or four levee districts in this bottom and they are each under a separate organization. The intention is first, to dissolve these and then reorganize one large district. It has been reported that several persons were drowned during the flood. At East St. Louis there were seventeen drowned. Ten or eleven, I think, resulted from carelessness. There were only four or five drowned on account of the flood directly.

THE WORK OF THE UNITED STATES GEOLOGICAL SURVEY IN THE STATE OF ILLINOIS.

BY MARSHALL O. LEIGHTON. (U. S. GEOLOGICAL SURVEY.)

The field work of the U. S. Geological Survey is in charge of three divisions, the topographic, geologic and hydrographic. The character of the work performed under these heads is well defined by the terms above given.

In 1901, and again in 1903, the topographic work was thoroughly presented to the Society by Mr. William H. Herron, and some action was taken which it was hoped would result in procuring legislative authority for the prosecution of a co-operative plan between the U. S. Geological Survey and the State of Illinois. The project failed by reason of several causes. The matter was agitated by the authorities of the Survey after the same manner that has been followed in the case of other States in which the issue has terminated successfully. No more can be done by the Survey and it now remains for the institutions, associations and individuals of Illinois who are interested and who wish to see construction of a topographic map, to push the matter in such a way that success may be assured.

GEOLOGIC INVESTIGATIONS.—The work of the Survey along these lines during the year past has been under the immediate charge of Mr. H. Foster Bain. In 1903 the Geological Survey had field parties in both northwestern and southern Illinois. The work was of a preliminary character and was directed to the study of the lead, zinc and fluorspar deposits of the State. The particular object in view was the discovery of the distribution, mode of occurrence, economic importance and genesis of the deposits. In neither case were topographic maps available, so it was necessary for the field parties to make their own base. This was done with a plane-table, distances being obtained by pacing.

In southern Illinois, some 42 square miles in Pope and Hardin counties were mapped by this method on a scale of 4 ins. to the mile, the roads, streams and geological boundaries being traversed and plotted on the ground. The area mapped was so distributed as to include the more important mining districts, and also, by the aid of barometer readings, to furnish data for a north-south geological section from the Ohio River to Karber's Ridge. The formations (various rocks of the St. Louis, Chester and Pennsylvania class), were mapped, and the mines located and studied. An interesting result of the work was the discovery of a considerable number of occurrences of igneous rock in the region. The rocks found occur as dikes and sills, and include diabase, mica-peridotite and biotite-pyroxenite. In 1902, one such occurrence had been noted by Mr. W. S. Tangier-Smith near Golconda, but previous to that it had been believed that no such rocks were to be found within the State. The occurrence of these rocks, of considerable faulting, and the presence of minor amounts of stibnite and silver in connection with the fluorspar deposits strongly suggests a genetic relation between the ore bodies and these unusual conditions. This suggestion is in accord with the typical form of the ore bodies, that commonly are called fissure veins. The mines are now being worked to a depth of over 300 ft., and show no decrease in the amount of fluorspar, though the amount of lead and zinc present is, and seems always to have been, relatively unimportant.

In northwestern Illinois the work was centered around Galena. Nearly 300 square miles were mapped on a scale of 2 miles to the inch. This mapping was essentially a revision of a well made county atlas, and owing to the open nature of the country was much less difficult than that undertaken in southern Illinois. Jo Daviess County forms a portion of the upper Mississippi lead and zinc region, which, up to the opening of the silver-lead mines of the West, was the leading American source of lead. For some years very little mining has been carried on in the region, as the large bodies of easily obtained galena were mainly worked out. With the rise in the price of zinc in 1899, attention was attracted to this region, and recent metallurgical improvements have made the heavy iron-bearing blende which occurs there, salable. The result has been renewed mining activity, which, up to the present, has been directed more to the Wisconsin deposits than those in either Iowa or Illinois. Nevertheless, some 13 different properties in the Galena district are now undergoing systematic development and some of the mines have reached a producing stage.

The crude concentrates of the district are lower in value than those in the Joplin mines, and this offsets largely the advantage of generally richer ore bodies. The latter are of good size, lie near the surface and are easily prospected. At present the horizons which probably will be most productive have only been opened in one Illinois mine. While no very rapid development is to be looked for, an increasing production may be confidently expected.

HYDROGRAPHIC WORK.—The operations of the Hydrographic Branch of the Geological Survey are carried on under the supervision of three distinct organizations, stream gaging, hydrology and hydro-economics. Probably the most important hydrographic work is that of stream gagings. This consists in the establishment of permanent stations at selected points along the rivers of the State for the purpose of measuring the amount of water passing in the channels throughout the year. At these stations, gages are referred to permanent bench marks, the actual height of which may or may not be determined according to some established datum. These gages are read twice daily and the records are sent to the division headquarters at Washington each week. At intervals of about one month current meter measurements are made at each of these stations. There is no established time for such measurements, however, and when unusual conditions arise, such as extremely high or extremely low waters, the current meter measurements are made as often as is necessary to secure the data made available by such unusual conditions.

The object of conducting the work in the manner above described is to procure a rating table for the channel at the various points selected and when a sufficient number of measurements have been made to secure the foci necessary for the fixation of a flow curve, the amount of water carried by the streams can be determined by reading the gage height and referring it to the rating table.

The results of current meter measurements are published annually in the water supply papers issued by the Geological Survey, and in addition to this they are available at all times to engineers and other persons, who, for one purpose or another, find the data requisite or desirable. Among the advantages which arise by reason of the intelligent use of these data are the following:

1. The determination of the amount of water in flowing streams available throughout the year for domestic water supply.

2. The determination of the amount of storage capacity necessary to provide a constant water supply from conservation systems on drainage areas of various sizes.

3. The determination of available water for the generation of power at favorable points. This largely depends, as is appreciated by engineers, on the minimum flow of the streams.

4. The derivation of formulas showing the relation between precipitation and run-off. The value of these formulas is not entirely confined to theoretical considerations. It has been found valuable in the case of streams subject to overflow, where in the event of a certain amount of rainfall on the drainage area, the height at which the water will rise can be determined at a sufficient time in advance to enable those who have crops and other valuable property in exposed positions to either remove them or to provide means to prevent their destruction.

There are other uses to which the data gathered by the Hydrographic Division may be put, but the general values are expressed in the foregoing paragraphs.

The following named stations are now being maintained in Illinois:

A. Des Plaines River: (1) Above mouth of Kankakee. (2) Above mouth of Jackson's Creek.

B. Illinois River: (3) Near Minooka. (4) Near Seneca. (5) At Ottawa. (6) At La Salle. (7) Near Peoria.

C. Fox River: (8) At Ottawa.
D. Rock River: (9) At Rockton above mouth of Pecatonica Creek.
(10) At Rockton below Pecatonica Creek.
E. Sangamon River: (11) At Springfield.

The stations on the Des Plaines and Illinois Rivers were established by reason of the importance of the Chicago drainage canal and the disputes which have arisen with reference to its effect upon the Illinois River. It has become a matter of great importance to the people of Chicago as well as those all along the Illinois valley. Since the opening of the drainage canal, practically every flood or ice gorge, and, in fact, nearly every unusual occurrence along Illinois River, has been alleged to be due to the drainage canal. Numerous suits have been entered in the courts which have been extremely costly both to th Sanitary District and to the contestants along the Illinois River. Little or no data of permanent value was available to show whether or not the effects of the Chicago drainage canal were as serious as believed. The data being collected will show conclusively at which point the waters or any flood enter the stream. The gaging stations are selected with reference to the entrance of important tributaries of Illinois River.

In addition to the mere question of alleged damages by reason of the Chicago drainage canal there are important considerations with reference to river shipping. In order to develop a river so that it will afford transportation facilities, it is necessary to know the amount of water available at various seasons. The results which are already at hand are extremely interesting when studied from this view-point.

The stations on Rock River were established for the purpose of determining the amount of power available at favorable points along that stream. This is also true of the study of Fox River. The gaging station on Sangamon River was established for the purpose of studying the general relation between rainfall and runoff in central Illinois, so that data might be at hand whereby the amount of water available for domestic purposes could be determined by the cities and towns in that part of the State. The work of gaging streams in Illinois has been continued about 16 months. The stations on Rock River were established during the spring of 1903.

HYDROLOGY.—The duties of the Division of Hydrology consist of the study of the occurrence and volume of ground waters and their availability for domestic use. These studies involve a geological study of the water-bearing strata and the determination of the limits beyond which water from such a strata is not available, and the probable permanence of the same as a source of public supply. The only work performed in Illinois along these lines during the past year has been a superficial study of the artesian basin in the northern part of the State.

DIVISION OF HYDRO-ECONOMICS.—Under this heading have been included investigations into quality of water, with special reference to the effect of this upon the industrial development, and the value of various sources of supply for domestic use or other industrial purposes. The economic value of water and its fitness for use in the various lines of special water-supply development is greater than has generally been believed. Enormous amounts of money have been wasted because the adaptability of water in many particular lines has not been properly determined, and little or no information is to be had concerning this matter in the greater part of the United States. It frequently happens that an ample supply of water can be had from a river, lake or well, but the mineral impurities are of such a character as to limit or prevent its use, necessitating large expenditure to procure water elsewhere, or, in some cases, the failure or suspension of the industry.

Or, again, it frequently happens that a source of supply originally of excellent quality has become contaminated by sewage or other organic matter and cannot be used without filtration or other treatment, or has become polluted as to cause vast losses through sickness, death, destruction of ice crop and of fisheries and depreciation of realty values. Extended discussions of this subject have been published in Water-Supply Papers No. 72 and No. 79. In short, the quantity of water, while important, must be joined with considerations of quality in any determination of the water supply of the country or in the preparation of reports of the best methods of utilizing water resources.

The plans that have been made and followed up to the present include the collection of all analytical data, and the arrangement and classification of the same for ready reference and use. These analyses include principally the inorganic determinations made for the purpose of showing the proportion of various harmful salts, and the ordinary sanitary analyses, which show the amount of organic matter and its state of oxidation, together with various other determinations, such as color, turbidity and hardness. The former class of determinations are of especial importance to all interests involving the use of steam boilers, such as railways and stationary steam-power plants, and to manufacturers who are obliged to use care in the selection of waters which will not be detrimental to manufactured products which are the result of finely balanced chemical processes. The latter series of analyses find important use in the above-mentioned departments of industry, and, in addition, is of enormous practical benefit to municipalities and institutions seeking domestic water supplies.

Of exceedingly practical value is the investigation which has been begun with reference to the effect of different industrial wastes upon the streams of the country. It was found that the damage done to riparian rights and allied water values by certain kinds of trade refuse amounts to many millions of dollars; this, too, notwithstanding the fact that in the majority of cases such destruction is needless and easily prevented. Of singular interest is the fact that there is usually much valuable material in industrial wastes which might be economically recovered.

The hydro-economic work in the State of Illinois has not been prosecuted vigorously for several reasons, the most important of which is that an unusual amount of data is already at hand as a result of the excellent work of Prof. A. W. Palmer, of the University of Illinois, and the investigations of the St. Louis and Chicago authorities in connection with the litigation along the Illinois River. It is the intention to take up the work when this litigation is closed and to complete the work in those parts of the State not represented in the above-mentioned investigations.

DRAINAGE AND IRRIGATION IN THE MIDDLE WEST.

BY C. G. ELLIOTT: (MEMBER).

While the drainage of agricultural lands has received the favorable attention of the people of the middle west for a quarter of a century, yet nothing could tend more to the general benefit of the art than a clear understanding of the experience gained in that time and its application in carrying out future operations. As a well-recognized element of progressive agriculture, it does not lack historical precedence, for Pliny, a writer of the first century, announces the first principles as well as the value of drainage in the declaration, "The cutting of ditches and the drying of wet fields is most useful." During the past century eminent engineers, hydraulicians, and statesmen have thought it a subject well worthy of their best efforts. Governments and societies of national note have used their best offices to promote its advancement.

There are a few important matters essential to the success and extension of drainage practice which should not be overlooked. Each agricultural section with its several types of soil and the crops to which they are adapted, presents a new phase of the subject for experiment, new problems of a practical nature to be worked out, and, often a different regime to be followed in securing the best results from the work, though the underlying principles may have been established a century previous. Mr. J. Bailey Denton, the accomplished English engineer, in giving a retrospect of 40 years' experience in drainage, says:

> I have been connected with drainage sufficiently long to be a witness to the complete overthrow of several opinions which have prevailed for a time, and am bound to acknowledge that every day's experience, while strengthening some views and modifying others, has proved to me that I have as frequently been wrong as the rest of my brethren, and that after all the intelligence and outlay that has been brought to bear on the subject, there is yet much to learn ere it can be said that we are perfect in the art of drainage. It is plain therefore, that we ought still to receive and respect the opinions based upon experience, even though those opinions may differ from our own.

Notwithstanding what has been done in "this most useful art," as Pliny calls it, each agricultural section has been obliged to submit to more or less crude work by way of experiment in order to ascertain methods which would prove the most efficient. The transfer of successful eastern practice to the middle west has in many instances proved disappointing. The differences in existing conditions have brought to light unforeseen difficulties which had to be met. Mr.

E. G. Minor, of Jefferson County, Kentucky, said to the writer not long ago:

> The reading of Col. Waring's book on drainage, while impressing me with the value of improvement, prevented me for ten years from engaging in the work myself because the expense of drainage such as he described and recommended was greater than my land would bear. I have now drained 500 acres in such a way that the returns from the improvement are in every way satisfactory.

The features of the work which differ materially from eastern practice and which members of this Society have had no small part in determining, may be enumerated as follows: 1. The necessity of large and deep channels constructed by special steam dredges, in the absence of sufficient natural streams. 2. The use of larger drain tiles than were ever before employed for agricultural drainage. 3. The construction of extended systems on less grades than had previously been thought practicable and a greater distance between individual lines of drains than had hitherto been practiced.

The adaptation of well-known principles to the needs of the middle west was, notwithstanding many disappointments, accompanied with sufficient success to encourage a continuance of the work. Efforts to improve land are always circumscribed by that unyielding line bristling with the ever-recurring question: Will it pay? The cost must be figured down until the increased production which may reasonably be expected will be returned in a short time. The custom of capitalizing the cost, as is done in commercial and industrial investments, so that the interest will be satisfactory and the entire amount will pay out in 10 or 15 years, is not usually in favor with farmers. If the matter had been treated in this way, much more complete work would have been done in drainage than we now find. Notwithstanding all experiments and mistakes which have been made, it may be said that no section of our country has given as large returns for the amount invested in drainage as the middle west.

It is desired in this paper to take up the subject in its present status, and, in the light of experience, to indicate what advance steps may be wisely taken toward the future development of the productiveness of the soil. It does not require any abstract logic or far-fetched reasoning to show that the prosperity of the engineer and other industrial professions is closely connected with agriculture and hence should engage the careful attention of a fair proportion of the membership of this progressive society.

Moisture conditions of the soil are now understood to be equally important with chemical conditions. They largely govern the quality and quantity of production. The distribution and conservation of the moisture of the soil are of vital importance to the cultivator; and the engineer in dealing with drainage projects, should understand these factors of the problem as well as those connected with conduits, grades, and specifications. The distribution of the rainfall and the control of soil water in such a way that vegetable growth may be promoted, will do much toward the solution of the flood and drouth difficulties which are always sure at certain times to provoke sharp discussion. The soil is the storage reservoir of the middle west. Every effort should be made to retain all the water possible below the plane where it will injure plant production. This must be done by putting the surface in an absorptive condition so that the larger part of the rainfall may pass into the soil and there be distributed, and the excess pass off through the lower soil to channels provided for it.

The changes in surface conditions which have been brought about by the settlement and improvement of the country and the changes which are made each decade by reason of good husbandry have greatly affected the distribution of the rainfall in all portions of the country. It is to be regretted that no investigation of the run-off of lands has been made with reference to the effect which changes in the surface by cultivation and improved drainage conditions have made. Close observers tell us that the flood height of streams is greater than formerly, and ascribe it to the increased drainage and improvement of land which have been made within the watersheds of the various streams affected. Material changes have been made in the general management of the country incident to its improvement, which undoubtedly have a bearing upon the discharge of streams and their behavior after continuous rainfall. Some of these changes may properly be noted in considering this subject: The long grass of the prairies has all been cut short or pastured closely so that the water is not so readily retained, and many shallow channels have been made to remove it from the improved surface. Undulating woodland has been denuded of its undergrowth and pastured until the surface has become so smooth that it offers but little resistance to the flow of water from a heavy rainfall.

These changes produce flood heights of quick rise and short duration. Before any artificial drainage was provided for, the ponds, sloughs, and large level tracts covered with verdure retained large volumes of water before any could flow off to the streams. When the earth had become fully saturated and every surface depression was full of water, a heavy rainfall would produce a flood in the streams because there was no reservoir capacity left and all precipitation, under such conditions, was discharged at once into the streams. This produced higher floods of longer duration than any experienced under any other conditions, as many of us who have been brought up on the prairies will bear witness. The floods experienced in Kansas, Missouri, and Iowa during the past season came largely from lands which had undergone the first stage of improvement, while those tracts which were well cultivated and had free underdrainage were not seriously injured. The following testimony before a committee of Parliament by J. Bailey Denton in 1862, with reference to the effect of underdrainage upon the flood heights of streams was given after an observation of 30 years:

> Underdrainage hastens floods and increases the quantity of water thrown into the valleys: first, by the improved outfalls, which discharge the water from the drains, as well as such waters as flow off the surface, and, second, by arresting from the atmosphere that water which in the absence of underdrains would be evaporated. It is more by these outfall works than by drainage itself that the upland waters which were previously detained for want of outlet are now thrown down more rapidly into the valleys. Up to the time when the rain has filled the soil and brought it into a state of repletion, that is, saturation, the drained land absorbs and retains the rain falling on its surface and so retards overflow and delays floods.

We may conclude that our present practice gives fitful and uneven outflows at certain seasons of the year, but that the great and lasting floods which prevailed when both streams and land were in their natural state have been greatly modified by our drainage practice. It may be suggested that engineers and others who attempt to promote comprehensive improvement of this kind should consider the following propositions: First, the absorption of all the water possible and its diffusion and retention to the full capillary limits of the soil are valuable adjuncts to its fertility. These objects can be accomplished by deep drainage of the more open soils and the more complete aeration and drainage of the close soils so as to increase their absorptive properties; also by the terracing of hillsides, pastures, and woodland to retard the run off and permit a greater percentage of the rainfall to be absorbed. Second, the work of improving the larger receiving streams should take into account the narrowing of the bottom lands whose improvement encroaches upon the flood capacity of the channels, and also should take into consideration the fact that the efficiency of streams for carrying run-off without injurious overflow depends upon whether the discharge of entering streams takes place consecutively, that is, in such a way that the flood from one stream passes off before that of another arrives, or whether different flood discharges arrive at a given point concurrently. Under the latter circumstances floods nearly always occur.

Wet seasons occur at irregular intervals of from five to eight years in which continued and unusual rainfall during a part of the year overtaxes ordinary drainage provisions. This may be true of only one section of a valley or even only one part of the State, yet greater damage may be done than the cost of providing ample overflow channels. The entire watershed area taken in connection with the modification of former drainage facilities should be considered in plans for the improvement of the larger outlet streams. This has been neglected in the execution of many drainage works found in the middle west, but is now regarded as a prominent matter in both law and engineering.

With reference to the bearing of these two propositions upon proposed future improvements, and the necessity for the exercise of greater foresight in the conservation and final disposition of drainage, it may be said that so far, drainage projects have been prosecuted as individual interests have dictated. Material changes have been made in one part of the catchment basin of a stream without corresponding changes being made elsewhere. It is but natural that complications should arise in the larger streams receiving the flow, and that there should be sudden fluctuation and consequent overflows until the lower channels become improved in a manner commensurate with the changes at the head waters. Our rainfall is erratic and not uniformly distributed, requiring both reservoir capacity and greater drainage facilities than nature provides.

The use of irrigation as an accessory of drainage in the middle west is commending itself to the attention of some who grow crops of high value which are peculiarly sensitive to any deficiency of moisture. In such cases the use of an artificial water supply to be applied at critical times has proven profitable. Experiments were made under the direction of the Irrigation Investigations of the Department of Agriculture, at Madison, Wis., in 1901. In summing up the results of this experiment, the report says:

> Supplemental irrigation of heavy soils in climates like Wisconsin may increase the yield of hay from two-fold to three-fold; the yield of ear corn, 25 to 35 bushels per acre; potatoes, 80 to 100 bushels per acre. The profits of irrigation at Madison from clay loam were about $20 per acre for hay; $11 per acre for corn, and $73 an acre for potatoes. The cost per acre for irrigating, that is, the expense of pumping, not including interest on the cost of the plant or deterioration in its value, was $6.68 per acre.

Experiments in other parts of the country indicate that as a supplemental improvement irrigation may be employed in many instances with very great profit. It is, however, one of those improvements contingent upon the high value of land and its intensive cultivation now found near cities or where market facilities are good. Market gardeners and fruit culturists find that where water can be obtained and applied within reasonable limits of expense, irrigation is profitable. As soon as the art of irrigation in humid climates becomes better understood, it is destined to play a large part in the management of high class and scientific truck farming.

The advancement in agriculture made possible by more complete improvement of the soil by drainage has been marked and is encouraging to every friend of this most ancient and abused occupation. By reason of improved soil conditions many products which were formerly neglected have been brought to greater perfection. Drainage supplemented by irrigation in humid climates and irrigation supplemented by drainage in the arid regions represent a base of operations for the attainment of the highest results in agriculture. To produce these ideal conditions in the various types of soil under different climatic conditions by the direction and control of the water, is certainly a subject worthy of the best efforts of the engineer.

The State of Illinois has been foremost in pushing drainage improvements, and her prominence in agriculture is largely due to this fact. The sanitary reputation of portions of the State was at one time such that people from the east persistently refused to occupy some of her most fertile lands, but to-day it is observed that no localities have better sanitary records than the level lands of Illinois which have been adequately drained. There are, however, new phases of questions relating to the development of lands for production and for convenient and healthful homes which present themselves and should be met by those who deal with engineering in rural affairs. As land becomes older, more thickly settled, and higher in price, it must receive more intensive and scientific treatment in order to meet the commercial demands required. The sanitation of homes in both country and village will call for more intelligent direction. More complete facilities for carrying out the best practice in agriculture are demanded. In an agricultural State, agricultural engineers must keep abreast of the times and stand ready to adapt sound engineering knowledge to the needs of this, the largest industrial interest in the state. Only a few points pertinent to the subject have been suggested. In a great state traversed by streams many of which have large and level watersheds, a state bordered by great rivers and possessing a variety of climate and soil fertility which has been only partially tested, it is safe to predict that further development will follow that already made and that engineers will be called upon to solve many problems in connection with drainage and irrigation before the agriculture of the State will reach its highest development.

MEASUREMENT OF FLOW IN SEWERS.

BY ARTHUR N. TALBOT: (MEMBER).

The determination of the flow of sewage through a sewerage system may give data of considerable value to the engineer in charge of its maintenance, and such data may prove to be of service to the profession at large. The dearth of knowledge on the carrying capacity of sewers and on the run-off through sewers is largely due to the difficulties which seem to be connected with the gaging of sewers, though the fact that engineers generally have little to do with the sewerage system after its construction is a large factor.

The purpose of the measurement of the flow through a conduit may be scientific or general. The measurement of the flow of water to be used as a contribution to the science of hydraulics requires great care in arranging apparatus and in determining conditions. For the general purposes of the engineer, however, approximate methods and even rough gagings may give information which may be of much value. Data on run-off from rainfall for varying areas and varying conditions of slope and character of surface, amount of ground water percolating into sewers, data for use in determining necessary capacity of purification plants to be built in the future, the location of obstructions or irregularities in sewers, and other information of value may be obtained by engineers by the use of such means. It is proposed here to discuss briefly some of the methods which may be applied without great expense to measurement of the flow in sewers and which are not expected to give scientific accuracy in results. There is little that is new in the methods, but it is hoped that the suggestions may prompt engineers to collect and record data on sewer flow.

1. Gradient and Depth.—When a sewer is built in such a way that the ordinary formulas for flow in sewers give a fairly accurate measure of its carrying capacity, advantage may be taken of calculations from these formulas. From the known gradient and size, the discharge of the sewer flowing full may be calculated by Kutter's formula or other method. Knowing the depth of flow in the sewer, calculate the proportional depth of flow and multiply the discharging capacity for full sewer by the proportional discharge at the given depth found from a table or diagram. A diagram giving the proportional flow at different depths may be found in text-books on sewerage.

In making the observations, care should be taken that the depth is measured on a representative stretch of sewer and that changes of section like those which may occur at a manhole or other point do not interfere with the regularity of the flow. It must also be remembered that the formulas are not very reliable at small proportional depths of flow, and that deposits and irregularities may also interfere with accuracy of measurement at low depths. For flat gradients, the gradient of flow may not be the gradient of the invert of the sewer, and levels of the surface of the sewage should be taken, since a small difference in hydraulic gradient will affect the flow considerably. An uncertainty in the hydraulic gradient to be used will make the calculated flow unreliable. This method is very convenient, and if applied to the determination of flow during storms would give information of value in the design of storm sewers. It generally may be expected to give results within 15 per cent., and frequently within 10 per cent., of the actual flow. As an illustration, suppose that a sewer 6 ft. in diameter on a given grade has a calculated discharging capacity when full of 110 cu. ft. per sec. With a depth of sewage of 2.1 ft., equal to 0.35 of full depth, the proportional discharge may be found from a diagram or table of proportional flow to be 0.25 of full discharging capacity: 0.25 of 110 equals 27.5 cu. ft. per sec., the flow of the sewer.

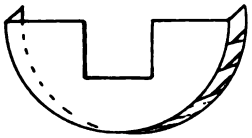
2. Float Gaging.—The surface velocity in a sewer may be determined by noting the time required for a float to pass over a measured length of sewer, generally from manhole to manhole. Two difficulties may be in the way. The cross-section of sewer at low depths may not be uniform and the flow may not be such as to keep the float in the middle of the channel, and the float may even be caught and held by obstructions. For the larger depths of flow these objections do not generally hold. A considerable impediment to accuracy lies in the uncertainty of the relation between the surface velocity V as found by the float and the mean velocity v of the sewer. As a general value the formula $v=0.8V$ may be used, though the co-efficient will range from 0.75 to 0.85. Having the mean velocity, the discharge of the sewer may be obtained by multiplying the area of water cross-section by the mean velocity. Care must be taken in determining this cross-section. In pipe sewers on flat gradients and on many brick sewers the fungus growth which forms may considerably reduce the area of cross-section, and this and other forms of deposit or obstruction must be considered in deciding upon the clear area of water cross-section.

The float must be of such form as to take the full surface velocity and to keep in the middle of the channel. A short cylinder weighted at the bottom to hold it down so that its upper end will not show much above the water surface is a good form. The float is simple and inexpensive. Of course, it must be known that there are no obstructions in the sewer. Sub-surface floats have been used, and also bodies occupying all or nearly all of the water cross-section of the sewer, but these are not to be recommended. The relation between the velocity found by the sub-surface floats and the mean velocity in the sewer is not known for all cross-sections, and the latter method does not give the natural flow of the sewer, since the water does not flow as a piston.

3. Color Gaging.—A method which has given very satisfactory results is the use of a strong coloring matter which will mix with the sewage through the depth of the sewer and not become segregated at the top or bottom of the channel. A material recommended is fluorescein, a standard chemical which when dissolved in a small amount of ammonia and mixed into a quantity of water gives an intensely strong green color which may readily be detected in the sewer even when diluted by spreading out over a considerable length of sewer. To get the same temperature and specific gravity it is best to use sewage as the liquid. A bucketful of this mixture may be suddenly inserted in the sewage flow at a manhole and the time taken to reach another point in the sewer observed. A tinge of color will advance in front of the body of color and a further tinge will lag behind, but the bulk of color will for a sufficient length of sewer remain compact enough to enable the average time of flow to be determined quite closely. Ordinary dyes and most other coloring matter do not work satisfactorily, but fluorescein mixes well, is readily distinguished in sewage, and is not very expensive. The amount of chemical resting on a knife blade will strongly color a bucketful of water. Of course, it may be desirable to use mirrors and throw sunlight into the sewage. For flow in pipe sewers and at partial depth in small brick sewers the color gaging is to be recommended. The velocity found may be considered the average velocity, and the discharge is calculated by multiplying this velocity by the area of water cross-section measured as in other cases.

4. Weir Gaging.—Weir gaging usually implies the construction and use of somewhat elaborate weir chambers, but a weir may be placed in a sewer so as to give fairly accurate measurements at partil flow of sewer without much expense. For pipe sewers the weir device may be inserted in the sewer just above a manhole. For larger sewers the device may be placed at any convenient point. Either the contracted weir or the suppressed weir may be used. The former is advantageous for small flows; the latter for gaging larger quantities.

For small sewers it may be made of a plate of galvanized iron about a half circle or disk in form, somewhat smaller than the sewer section, and having the circular edge cut and turned back, forming a hinge to aid in holding the gasket of cloth or other material used to secure a tight joint against the sewer wall. This may readily be braced in place. In this semi-circular dam is cut a rectangular notch for a contracted weir. The crest of the weir should be straight and sharp. The measurement of the head may be made with an ordinary rule, if great accuracy is not desired. For



larger sewers, stiffer weirs and better arrangements for holding in place and preventing leaks may be desirable.

To calculate the flow the ordinary formulas for weirs and the value of co-efficients given in hydraulic tables may be used. For the short weirs used with small sewers the following formulas will give results within the degree of accuracy ordinarily desired.

For contracted weirs

$$g=3{\cdot}2lh^{\frac{3}{2}}$$

For suppressed weirs

$$g=3{\cdot}5lh^{\frac{3}{2}}$$

where g is the discharge in cu. ft, per sec., l is the length of water in feet, and h is the head on the weir in feet. For large flows it will be necessary to take the velocity of approach into account. This may be done by first calculating the discharge by disregarding the velocity of approach. Then add to the measured head the velocity head corresponding to the velocity of approach obtained with this tentative discharge. Use this sum as the head in making final calculations. Weirs constructed as here described may be used in sewers having low or medium velocities for flows up to, say, three-tenths of the depth or 20% of the sewer's discharging capacity. For greater quantities and for more accurate work it may be feasible to construct a box or channel at the outlet and arrange a weir for measuring the discharge.

5. Other Methods.—The various other methods of gaging streams may be utilized in the measurement of flow in sewers. For large sewers the current meter will be of service. The gaging may be taken at mid-depth or other point at which the relation between the velocity and the mean velocity of the whole channel is known, and the mean velocity calculated from the gaged velocity and this known relation; or the velocities for the various parts of the cross-section may be observed and the flow for the whole cross-section calculated by adding the amounts found for the various partial cross-sections for which the velocities were observed. For smaller sewers it may suffice to move the current meter over the water cross-section and consider the velocity thus found to be the average velocity in the sewer. A form of current meter should be used which will not easily become clogged with the floating matter of the sewage. In some locations it may be feasible to turn the discharge into ponds or reservoirs and measure the quantity discharged by displacement method. If the sewage is pumped, the pump may be used as a meter.

The measurement of the flow in sewers not only gives information concerning the quantity of sewage carried, but may be used to locate obstructions or irregularities in the sewer system and to determine where large additional quantities of water enter the sewer. The levels of the sewage flow taken at each manhole will show a considerable variation in the platted hydraulic grade line, in case there is an obstruction in the sewer like tree roots or local deposits. Gagings will show a smaller flow through the sewer for the observed depth when the section is decreased by fungus growth or deposits of sediment. Measurements may determine whether an excess of flow in sanitary sewers over the amount known to come from buildings is a general infiltration of ground water through the joints along the whole line of sewers or whether it is concentrated on a stretch between two manholes. In selecting the method of measurement to be used for one of these purposes care must be taken to avoid a method whose inaccuracies and uncertainties for the conditions likely to be found may give erroneous results and throw doubt on the investigation.

Hydraulics still contains many fields requiring investigation, and the hydraulics of sewers invites the inquiring engineer to determine flows and give definite data on storm-water run-off and other sewage flow. Will not the members of this Society aid in doing this?

DISCUSSION.

C. B. Burdick: There is another possible method that has occurred to me of measuring the volume of flow in sewers, and that is by the use of the Pitot tube. There was a paper read some two years ago before the American Society of Civil Engineers on the flow of water in cast iron pipes. In the tests described, observations were made by the use of the Pitot tube, and that paper was pretty generally discussed. There were a number of engineers, including Mr. Edward S. Cole, of Chicago, who had made extended investigations of pipes by means of this tube. I have used a small Pitot tube, that registers simply the velocity of the flow, in gaging the flow through flumes supplying water wheels. It has occurred to me such a tube might be used in the measurement of flow in sewers.

REPORT OF THE COMMITTEE ON DRAINAGE.

A great many inquiries have been made by letter, and but a few have been answered, and a heavy proportion of the replies are too indefinite to be available in the collection of reliable data. As far as this committtee can learn, there is practically no drainage in the southern part of the state. From what little information could be obtained from the reported sales of the tile factories, and from the general tenor of the replies to inquiries, it would appear that about 8,000 miles of tile were laid in Illinois last year. As this is more than ever before reported, we will state that the amount was obtained by taking the average of the towns which did report and applying it to all the towns in central and northern Illinois. The reports varied from practically nothing to "$6,500 worth of tile, mostly 4-in.," sold at Piper City, Ford Co., and laid in the towns of Pella and Brenton, or probably 30 miles to the town.

The mean of all these reports is about eight miles to the town, and the factories report sales which nearly tally with it. Of the 1,550 towns of the State, the southern 550 were excluded in the estimate. In Kankakee County about 60 miles of tile drains were run by engineers, and this does not exceed 60% of the amount laid, which would make for that county about six miles to the town. Uncertain as the total amount may be, it is equally certain that the excessive rains of 1902 and in the early part of 1903 gave a great impetus to the tiling, and that much more than the usual amount was laid. Fully 15% and probably 20% of the work was in taking up old tile and replacing it with larger size. As far as can be learned, all the tile taken up was laid, either without consulting or against the advice of an engineer, but the engineer is likely to be blamed for its failure.

The dredge ditching for the last two years has been more closely confined to straightening and deepening old creeks and water courses, in many cases reclaiming so narrow a strip of land that 20 years ago it would have been hard to find an engineer to say that the benefits were equal to the cost. In the town of Washington, Will County, the channel of Trim Creek from its head to the line between Will and Kankakee Counties, a distance of over seven miles, was straightened and deepened at a cost of about $12,000, and the land actually benefited was taxed $28.61 per acre. This work was finished last spring, and now a petition is out for the formation of another district, the object of which is a like channel for Pike Creek for a distance of 8 or 10 miles at an estimated cost of about $1,800 per mile. Petitions are also out for the formation of two drainage districts in Kankakee County, the object of each being the improvement of an old watercourse; part of the way a creek and part an old-fashioned prairie slough which has furnished a very poor outlet for the tile drains of the contiguous farms. Both of the latter districts contemplate tile drains, each about seven miles in length, and costing over $2,000 per mile. The great advance in the price of land has made this work not only possible, but very profitable, and districts are springing up all over the state, but, as most of them are formed under the Township Drainage Act, and the only record of them is with the town clerk, it is very difficult to get much definite information.

In the drainage report of 1900, allusion was made to the crying need of a better outlet to the Vermillion special drainage district. This has finally materialized, and recently the contract was let to dig a ditch 12½ miles long and 70 ft. wide on the bottom. It requires the excavation of over 800,000 cubic yards of earth at an estimated cost of about $100,000. This is to carry the run-off of about 170 sq. miles of some of the richest land in Illinois. The committee has been unable to ascertain the amount of money expended in this class of work, but feels safe in saying it is considerably above the average of the last six years.

An attempt was made to get a statement of the cost of maintenance of the Meredosia pumping station, also as to the degree of satisfaction it was giving, but we got no answer to our inquiries. Work in the great Kankakee marsh is all the while being done, but its entire reclamation is, it is feared, a thing of the quite distant future. This marsh has an average width of 9 miles and extends from Momence, Ill., to South Bend, Ind. Much of the way the river runs on a slight plateau which is from 1 to 3 ft. above the marsh. Whenever the river is high enough to overflow, the water runs out to what the old settlers call the "Shore Line," which is often 6 or 8 miles away. The slope of the marsh is about 15 in. to the mile. Across the marsh the slope is very slight, and, on the north side of the river, away from the river and to the shore line. The drainage of this tract is a difficult problem, and engineers, as well as the landowners, differ greatly as to the best methods of doing it. The methods most generally advocated are: First, to widen, deepen and straighten the river; second, to levee the river and make large drains parallel with the river and carried down until some unusual formation of land permits them to empty in the river; third, to levee the river and erect pumping stations. Much land has been partially reclaimed, and it is hoped that the proprietors will demonstrate which is the best method, and by all working under one system obtain better results. A single system, though it may not be the best, is better than a multiplicity of systems; some of which must necessarily be poorer than others, and when a failure of a part means, pretty nearly, a failure of the whole. More than $500,000 has already been expended in digging large ditches, and yet the magnitude of the marsh makes the work appear as but the bare commencement of its reclamation.

The greatly enhanced value of farm lands and the consequent increased price of rent, is stimulating a higher cultivation and a much freer use of fertilizers. The possibilities of our rich prairie soil have been partially shown by J. H. Powers, of Prophetstown, and L. D. Young, of Bloomington, who raised 205.73 and 189.65 bushels of corn per acre. No one has ever claimed that the limit of either tract was reached. It has been the general practice of drainage engineers to plan drains not to meet the need of the excessively wet seasons, which occur once in about ten years, but to meet the needs of the average season; and as much more as could be done with the loss of every tenth crop, a little less than ten years' interest on the increased cost of larger drains. But the loss of a crop of 200 bushels per acre furnishes a very different basis for calculation than the ordinary 40-bushel crop, and it is here where I think the blaming of the engineer will come in. The higher cultivation spoken of must include a system of irrigation, and if during drouths the moisture is supplied, when the rains do come, the absorption is necessarily lessened and the run-off correspondingly increased.

The use of the average rainfall and the average run-off as a basis for determining the size of drains is as unsafe as was the use of the average of replies in getting the amount of tile laid. These may serve as a guide, but it is certainly a blind guide, making many missteps. The mean run-off of the Kankakee Valley, as taken from a table of 40 years, is 23% of the rainfall. In the year 1891 the rainfall was 32.3 in. and the run-off 5.3 in., or 16½%. In 1893 the rainfall was only 28.8 in. and the run-off was 11.1 in., or 38.4%. So, also, the mean rainfall of Illinois for the 11 years from 1875 to 1885, inclusive, was 40.76 in. For the succeeding 10 years, was 34.62 in.; while from 1850 to 1902 it is 38.3 in. This average is obtained by the measurements of the different stations, and their range is surprising. The least range was in 1857, which was 12.3 in.; 27.5 in. and 39.8 in. being the extreme measurements. The greatest range was in 1861, 30 in. and 68.8 in. being the extremes. There are several years which very nearly reach these different ranges.

There is very little data obtainable in regard to the hydraulics of small areas, and farm drainage is really based upon the hydraulics of a rill, which is vastly different from the hydraulics of a river. A heavy down-pour may change the former into a raging torrent and scarcely disturb the flow of the latter. The power of absorbtion depends to a much greater degree than is generally supposed, upon the amount of vegetation which the land produces, thus bringing into the problem as new factors, the porosity and fertility of the soil. When the price of crops shall jump from $10 or $20 to $100 or $200 per acre, these questions will demand a far clearer solution than is at present furnished and will, we think, result in the use of much larger drains than have been, or are now recommended.

J. L. CLARK, Chairman.
C. A. PROUT,
E. H. WHITTAKER.

THE SURVEY OF THE CACHE RIVER.

BY A. H. BELL: (MEMBER).

A recent bill passed by the Legislature of the State of Illinois, appropriating $10,000, provided for a survey of the Cache River to ascertain the practicability of straightening and deepening the channel of the river for the purpose of prevening overflow of the bottom lands and for the drainage of these lands. The Governor appointed three Commissioners to carry out the purpose of the bill. W. A. Wall of Mound City; H. Kopher, of Marion; and A. Davisson, of Metropolis; these constitute the Cache River Drainage Commission.

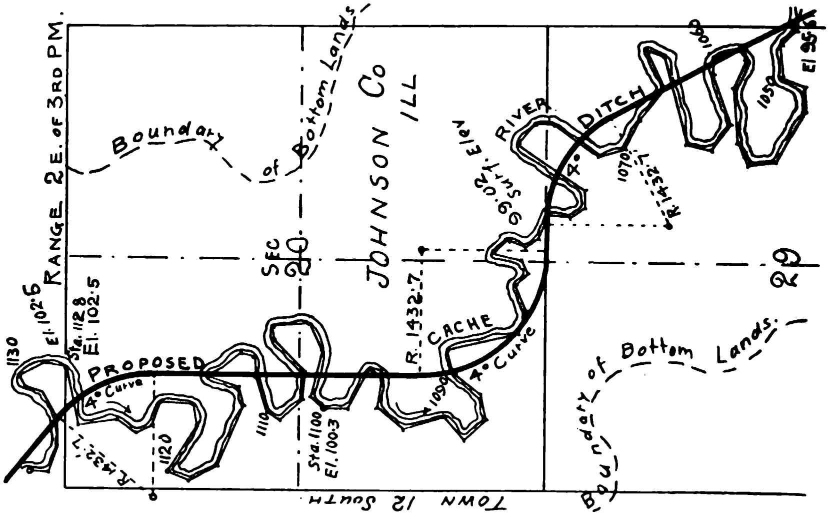
They proceeded at once to select a corps of engineers to complete the survey: 1 chief engineer (the writer), 2 assistant engineers, 2 chain carriers, 2 axe men, 1 teamster and 1 cook constituted the party which on Sept. 28, 1903, pitched camp on the banks of the Cache River about two miles above its mouth at the Ohio River, between Cairo and Mound City. The work is practically completed so far as the actual survey of the channel is concerned. Some additional work will probably be done later on concerning the watershed and tributaries.

The survey was made up stream for the purpose of getting out of reach of back-water from the Ohio River as soon as possible. At the time the work was commenced it was not thought possible to complete it during the fall and winter, but the season proved an exceptionally favorable one and the work has proceeded with but slight interruption. We have gone dry shod over many portions of the Cache River bottom, which, ordinarily, are covered with water the year around.

Commencing at the mouth of the Cache where it empties into the Ohio—with Station "O"—a deflection line was run by the transit man setting station stakes at all curves of any importance on the channel and taking the deflection angles to the right or left as the case may be. To avoid any errors in angles, readings were taken from both verniers and recorded in separate columns, the magnetic bearings of all lines being also recorded. The transit man was followed by the chainmen and leveler, who noted the surface levels at all stations, and also levels and cross sections of the present channel. There were also taken upon several occasions cross section surveys of the entire bottom land adjacent to the river, to give some idea of its general contour and topography. These cross section lines were run as nearly as practical at right angles to the general trend of the channel, and extended from bluff to bluff on either side. Levels were taken every 100 ft. The magnetic bearing of the lines was noted, also their crossing of the general deflection line or channel survey. The stakes set at all angles of deflection were such as one could cut from the material at hand and were numbered consecutively from Station "0" up. The numbering of the stakes was done by one of the chain carriers with a wood scribe, the figures being cut into the wood, to avoid any danger of erasure in the future. We were provided with two tents, one 16x20 ft. and the other 12x19 ft., also all the necessary camp equipage and a team and wagon to haul us to and from the work. The expense of the above was furnished by the State. All surveying instruments were furnished by the chief engineer. We aimed to work about three miles each way from camp before moving up stream; thus making the camps about 6 miles apart. However, where the roads were available, we worked much farther, sometimes going as far as 6 miles each way, thus making our move a total distance of 12 miles.

The location of the deflection line was maintained by frequent ties to section and ¼ section corners along the line. The platting of the deflection line has been kept up with the field work all along, so that we would know at all times how things were coming out. Only so much drafting has been done in the field, however, as was necessary to intelligently prosecute the work; the balance will be done in the office after the completion of the field work. The completed maps will be on a scale of 1,000 ft to the inch and will be drawn on ten separate sheets. An additional map on a much smaller scale will be made, showing the entire survey on one sheet. The maps will show all the meanderings of the present channel of the Cache River, from the Ohio River to a point about 7 miles northeast of Anna, Ill., which point is near its source. They will also show the levels along the river, cross sections of the channel and river bottom, boundary line of land subject to overflow, and other topographical features.

The general course of the river is as follows: From the Ohio it forms the county line between Alexander and Pulaski counties, as far as the junction of Mill Creek; thence it runs in a northeasterly course across the north end of Pulaski county to the northwest corner of Massac county, forming the county line between the later and Johnson county for a short distance. It finally passes through Johnson county in a northwesterly direction, and so continues for a distance of about 12 miles into Union county. That it is practical and feasible to reclaim and drain the greater portion of bottom land adjacent to the Cache River, is quite evident from the facts so far ascertained. The total length of the river by its meanderings will approximate 125 miles. By straightening the channel, it could be reduced to near half this distance. The total surface fall is 85 ft. The lower end of the river for 20 miles is subject to backwater from the Ohio; for this there is no remedy within reasonable cost. It is claimed, however, by property owners in this district that they do not care for the high water of the Ohio, for it comes at a season of the year when it is not detrimental to the farming interest. But it is then followed later on in the season by floods from the Cache River which render it useless. The cost should not exceed that of other similar enterprises in the northern portion of the State. The bottom land ranges anywhere from ¼ mile to 3 miles wide. The channel of the Cache is decidedly crooked in places, while portions of it (notably the lower Cache) would only need deepening. The upper Cache channel through the counties of Johnson and Union would have to be ignored almost entirely and a new and straighter channel constructed. Some idea of the nature of the channel and our survey may be formed from the accompanying map of a section of the work through Section 20 and the N. ½ of Sec. 29 in Johnson county. The distance by way of meanderings of the channel is 5.44 miles; the proposed ditch line crossing the same territory would be 2.11 miles, thus shortening the distance 3⅓ miles. The entire bottom land adjacent to the Cache River is of good quality of soil, the best by far in that section of the state. Much of it is covered with timber and the lumber industry predominates along its course.



REPORT OF COMMITTEE ON SURVEYING.

It is with regret that the committee has to report the failure in the Legislature of the bill for the proposed Co-operative Survey of Illinois. This bill which has been fostered by our President J. W. Alvord and Mr. W. H. Herron from its infancy, came nearer a successful issue at this session than ever before; the cutting down of the appropriation to $8,000 rendered the co-operative feature of the bill ineffective. This matter should be taken up again at the next session of the State Legislature and pushed to a successful issue.

The Committee reports the passage of a bill which denies the right to anyone, except the official County Surveyor, of applying the title of County Surveyor to himself.

In view of the apparent need of a well-founded system of bench monuments in our cities and towns, and on account of the irregularities in the elevations of bench marks in some of our cities, we commend the work which has been done in the city of Chicago in the establishment of bench monuments of great permanence and precision. We herewith give a short statement concerning the work.

The term "Chicago City Datum" was adopted by the Common Council and known as low water mark of Lake Michigan in the year 1847, as established by the trustees of the Illinois and Michigan canal.

The first plane or Bench Mark was placed at a point on the building at the southwest corner of Clark and S. Water Sts. From this Bench two others were established in later years, one on the County Court House and the other on the Lind Block, located at Randolph and Market Sts. This block was the first block in Chicago erected upon piles; it adjoins the river and was considered the largest and heaviest building of its time.

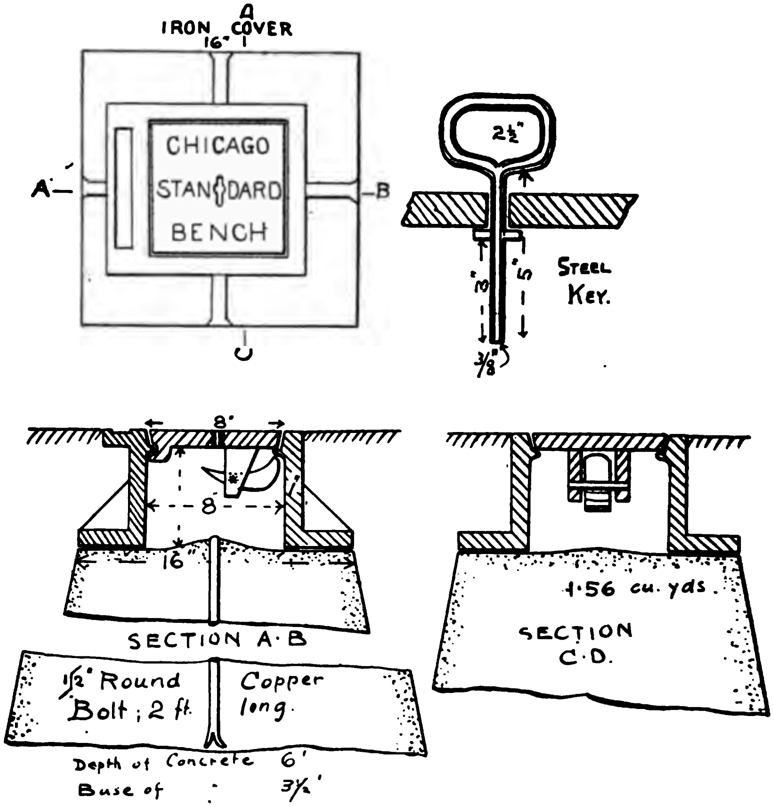
This building was constructed in the early fifties and the elevation of the Bench Mark on the corner of same was given as plus 15.775, meaning 15.775 above City Datum.

From a series of levels taken in different directions from other bench marks previously established, it was determined in 1895 that the elevation of this bench was plus 15.659, showing a settlement of 0.116 feet, which undoubtedly is correct.

Up to the time of the great fire in 1871, there were no material differences in the bench marks as used by the city engineers and surveyors. Each engineer established his own marks from the original bench mark, or from elevations previously established.

From 1871 on, when permanent buildings were being erected, streets paved and curbed, differences in the City Datum began to be very apparent among the engineers.

As the years passed, this condition gradually became very annoying and troublesome. In 1887 it was a common occurrence for one department to have an elevation of a bench mark from one to eight inches different from that of another department, and each making its improvements from the elevation of the bench mark as determined by its respective department; for instance the sewerage department would lay sewers from its datum and the street department would curb and pave the same street from its own, a different datum.



The same department would often conflict with itself. It was not an unusual sight to see curbing at street intersections, where one street was paved later than the intersecting one, differing from the other from three to six inches.

After years of persistent effort on behalf of several surveyors and engineers, the City Council finally in 1888 established over the city numerous bench marks. Under the direction of Mr. O. H. Cheney, chief of the Bureau of Sewers, there were about eighteen standard bench marks established and legalized by ordinance.

Unfortunately these bench marks were placed upon the base of towers and heavy buildings, which were liable to settle; the leveling was done by different engineers of differing ability and it was soon discovered that there were variations as great as three inches. Some of the benches were corrected by ordinance and they remained legal until repealed by another ordinance in 1898.

In 1895, Mr. W. H. Hedges, Assistant City Engineer, was directed to make investigation of the present "City Bench Marks," as referenced to city datum, particularly as to the settlement of the Lind Block bench mark.

His report explained in detail how he arrived at the conclusion that it had settled 0.116 in., and he recommended that an experienced and accurate engineer be made a "Bench Engineer" for the city. This recommendation was favorably acted upon by the City Council and Mr. Hedges was fortunately chosen as "Bench Engineer."

There are now over one hundred Bench Monuments constructed and legalized, and additional new ones are being added yearly. The work is being done very carefully and precisely, the maximum variation is 0.005 in.

Appended is a blue-print which shows the plan, cross-section and elevation of a Chicago standard bench monument.

J. G. MELLUISH,
EMIL RUDOLPH,
W. B. MCAULEY.

DISCUSSION.

MR. PADDOCK: The cities of Moline and Rock Island have established a system of benches in this way: We set a copper bolt, horizontally whenever we can, in some cases perpendicularly, in a brick or stone building. We use copper because it does not discolor. In cities with more rigid foundations and sub-soil than they have in Chicago, the danger of a building settling after its construction is very slight. With us, it is nothing, because our heavy buildings rest on the rock. We have 123 of these benches in Moline. We use about a ½-in. copper bolt, 2½ ins. long. We drill into stone or brick, and lead it in by tamping the lead around it, bringing it as nearly flush with the wall as we can. We have a record of the location of each one of these bolts in a book kept in the office of the City Clerk, in which is a full description of each one of those bench monuments. We took that type of mark from the bench marks used by the Mississippi River Commission in running its precise levels from Biloxi to the headwaters of the Mississippi. In the two cities we have four of these U. S. level bench monuments, made by the Mississippi Commission, which gives us a connection with Gulf mean tide at Biloxi, Miss.

THE ECONOMY AND ACCURACY OF VARIOUS METHODS OF LEVELING.

BY LESLIE A. WATERBURY: (MEMBER).

The writer has recently collected some data concerning the accuracy and economy of different methods of leveling, as applied particularly to profile leveling. The plan followed was to select a line and obtain elevations for profiles of it in several different ways. The results thus obtained were compared to determine the relative error and the relative amount of labor required.

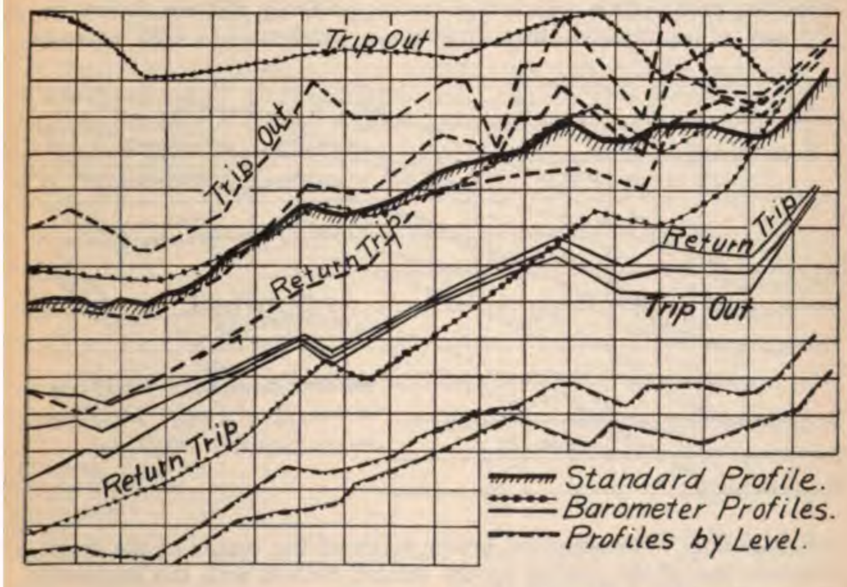
The "standard" profile with which the others were compared was obtained by measuring the line with a 100-ft. tape and taking ground elevations with an engineer's level at each 100-ft. station. The profile thus obtained is shown by the heavy black line in the diagram. The elevations obtained in this manner required 1½ hours' labor of a leveler, a rodman and two chainmen, or cost altogether 6 hours' labor. This is represented graphically by the line marked "Standard," under the heading of cost.

Elevations were also taken with an engineer's level by pacing the distances and taking readings at those points at which there was a change of grade. The results obtained in this manner are indicated on the diagram by the lines marked "Profile by Level," and in the cost diagram by the line marked "Engineer's Level." The number of hours' labor required for this method, as determined by averaging the results of two different sets of observers, was 44% of the time required for the standard method, as is indicated in the cost diagram.

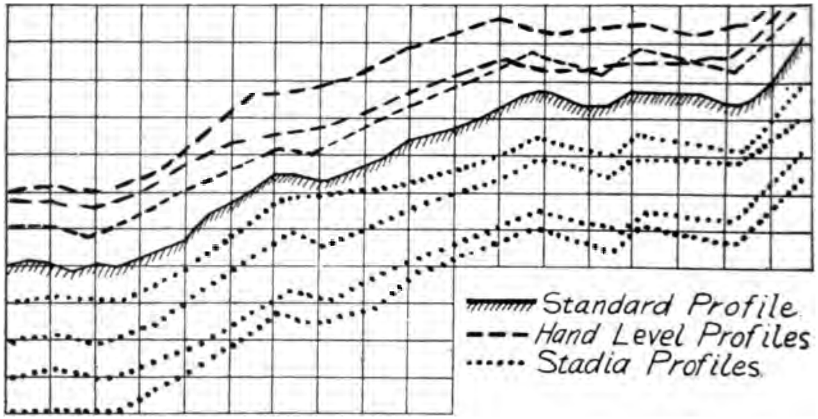
Other profiles were determined by taking elevations with the hand level, the stadia and the aneroid barometer, the distances being paced for the barometer and hand level. The results are shown. In the case of the barometer, elevations were taken going in one direction and then repeated while returning. Each elevation was determined by taking two readings, first lowering the instrument to the ground and then raising it to disturb the pointer. The final elevation was taken as the mean of the values determined in going and returning, so that four barometer readings were taken for each point. By taking readings both going and returning any constantly progressive error, such as uniform change in temperature, would be eliminated. That the changes which occur are largely of this character is well illustrated by the profiles, which show for each case the results for the trip out and for the return trip, and also, midway between these, the profile for the mean of the two. In one case, the difference of the readings of station 0 for the two trips was 71 ft., but the mean profile agrees fairly well with the standard.

The relative costs of these various methods, as determined by the time required for field work, are shown in the order of their magnitude on the cost diagram. In the case of the stadia the time required for reduction of field notes is greater than for any of the other methods, and on this account an addition of 15% is also indicated by the light extension of the line.

To determine the relative accuracy of the various cases, three methods were used. First, the mean error was determined. This may be considered either as the error in the determination of the difference in elevation between the first and last points, considering the result obtained by the standard method as correct; or it may be considered as the mean error in the gradients, since both will be the same. The results for the second method with the engineer's level should perhaps be the same as for the standard, except that the work for the standard would be a little more carefully done and the length of sights more nearly uniform. Instead of tabulating the error, the writer has subtracted the percentage of error from 100 and has called this value the accuracy of the method in question. The results are shown on the diagram.



The next method of determining the error was to note the maximum deviation between the standard profile and each of the other profiles. In this case the deviation cannot be said to be a certain percentage of anything, but the relative errors of two profiles will be the ratio of their deviations from the standard. That is, the accuracy is inversely proportional to the deviation. This would give the standard an accuracy of infinity, which would hardly be consistent. The maximum amount which the standard profile would deviate from the actual form of the ground would perhaps be a few tenths of a foot, or since the maximum deviation of the best profile by the second method with the engineer's level is a little less than a foot, it is taken as half of that value and its accuracy is considered as 100%. Two values are given for the engineer's level in this case, one of which has a question mark after it. This question indicates that the result after which it is placed is not to be taken as representative, for the reason that the profile from which it is taken evidently did not follow the by any other method, may indicate a gradient of +20 between



original line. The standard profile followed the center of the street, whereas one of the profiles by the second method with the engineer's level follows the grade of the sidewalk. This would not affect the cost nor the mean error.

The third method of determining the relative error was to superpose each of the other profiles upon the standard, so that the starting points coincided, and to take the sum of all the areas included between the two. The error is considered positive for areas both above and below the standard. In this case again the error of the standard is taken as half that for the engineer's level by the second method.

The reason for selecting these different methods is that the mean error does not necessarily determine the accuracy of any particular method. For instance, the grade between three consecutive stations might be zero, whereas elevations determined by the barometer, or stations 1 and 2 and —20% between stations 2 and 3. The mean error in this case would be zero, but the area error and maximum error would be developed. Again, some method may on the whole give a small area error and a small mean error, but may occasionally develop large errors. Such a case would be indicated by the maximum error. The diagram indicates that, for the observations made, the barometer was more accurate than the hand level, as far as mean error was concerned, but for both maximum error and area error the barometer was the least accurate of any instrument used. Another thing to be noticed is that the stadia developed less area error, but a greater maximum error than the hand level.

To the right of the values for accuracy in each case is the ratio of cost to accuracy, or in other words, it is the cost of a unit of accuracy. As regards mean error, the minimum cost of accuracy is obtained with the barometer, but for the other methods the barometer is the most costly. For maximum error, and for area error, accuracy is cheapest for the second method with the engineer's level. In any individual case the relative importance of each method of determining error would be dependent upon the character of the results desired.

TABULATED COMPARISON OF METHODS OF LEVELING.

	COST.
Standard	100
Engineer's level	44
Hand level	50
Stadia	43 or 50
Barometer	28

	ACCURACY.	COST DIVIDED BY ACCURACY
	(By Mean Error.)	
Standard	100	100
Engineer's level	99	45
Hand level	81	62
Stadia	96	45 or 52
Barometer	87	29
	(By Maximum Error.)	
Standard	100	100
Engineer's level	50	89
" " (?)	12	352
Hand level	23	216
Stadia	20	245 or 281
Barometer	8	360
	(By Area Error.)	
Standard	100	100
Engineer's level	50	89
" " (?)	17	267
Hand level	25	198
Stadia	37	107 or 135
Barometer	11	236

THE METRIC SYSTEM IN THE SURVEY OF THE PUBLIC LANDS.

BY S. S. GREELEY: (HONORARY MEMBER.)

It is not proposed to review the merits of the metric system, but to state some objections to the metric bill now before Congress. On Nov. 9, 1903, Mr. Shafroth, of the House Committee on Coinage, Weights and Measures, introduced the following bill:

> **On and after Jan. 1, 1905, all the Departments of the Government in the transaction of all business requiring the use of weight and measurement, except in completing the survey of public lands, shall employ and use only the weights and measures of the metric system; and on and after Jan. 1, 1906, the weights and measures of the metric system shall be the legal standard weights and measures of and in the United States.**

The metric units were made legal standards in the United States by the permissive act of 1866. It is not clear what additional force, if any, is given them by this bill. This bill specially excepts "the completion of the survey of public lands" from the use of metric measures. This exception seems to have been adopted on the suggestion of Mr. Charles D. Walcott, Director of the U. S. Geological Survey. While approving the use of the metric system in all other departments of the government service, he objected to its use by the land office on the ground that "the people have been so accustomed by long usage to think of all land measurement in terms of the English system of miles, rods, links, chains, acres, etc., that it will not be practicable to persuade them to adopt the metric system for land measurement."

It is true that in all the original surveys for the subdivision of the public lands into townships and sections, the Gunter's chain is the unit. Each full section is (theoretically) 80 chains, or one mile, square. A full township is (theoretically) a square of 36 of these sections. As villages spring up, the sections must be subdivided into lots of convenient size for homes. Roads must be made, sewers, and pipes for water and gas must be laid. On the lots houses must be built. All the materials for these various purposes—lumber, masonry, pipes, plaster, paint, glass, wire—are measured by the foot, or its multiple, the yard. The architect must, therefore, draw his plans to a scale of feet and he requires the surveyor to lay out the lot in feet and decimals, or in feet and inches. The surveyor, who subdivides a section, or a part thereof, into a town plat, anticipates all this, and measures its dimensions, not in chains and links, but in feet, and marks upon his plat of the new village or town the size of the lots and the width of the streets in feet.

When the metric units come into general use, all materials will be bought and sold by metric units; architects will draw their plans to a metric scale, and the surveyor will give metric dimensions to his lots and streets. If the survey of public lands be excepted from the operation of a metric law, the U. S. Deputy Surveyor will continue to use the almost obsolete Gunter's chain, and will record the dimensions in terms of the chain. In order to adapt the land for use for towns and villages, the land must be remeasured by a metric chain, and all the U. S. dimensions must be translated into terms of metres. Would it not be a great saving of time and labor, if the original survey of the land by the United States were made in the same units, which are to be applied later, when the land becomes closely occupied? If the metric system is ever to be adopted for all other uses, should it not be applied to land, which is the basis and the foundation of all things? If the metric system is to be brought into general use, in the government service, public convenience demands that the survey of the public lands should not be excepted.

Farmers, land owners and people generally are familiar enough with miles, rods and acres, but chains and links are familiar to few besides practical surveyors, and they are rapidly forgetting them. Nobody measures, or ever will measure, anything but land with a Gunter's chain. That instrument has had its day of usefulness, and has served its purpose well. Now let it make way for a successor better fitted to serve present needs. After a continuous practice of 50 years as a land surveyor in Chicago and in Cook County, I may say that I have not used or seen a Gunter's chain for the last 30 years.

SOME RECENT ENGINEERING MEASURING INSTRUMENTS.

BY GEORGE I. HERRICK (MEMBER).

The thought has come to me why a man in the field cannot carry with him in the form of a tape a convenient measure whereby angles may be measured or laid off on the ground with accuracy and dispatch. For such a tape I have chosen the scale of chords as a convenient function. Take a tape and divide it into three parts, AB, BC, CD, each of the first two being equal to 29.289314% of the entire length of the tape, and the third making the balance, or 41.421372%. Divide this third portion, CD, into a scale of chords of a circle whose radius is equal to AC, and graduate this on the tape with the chord of 0° at C and the chord of 90° at D.

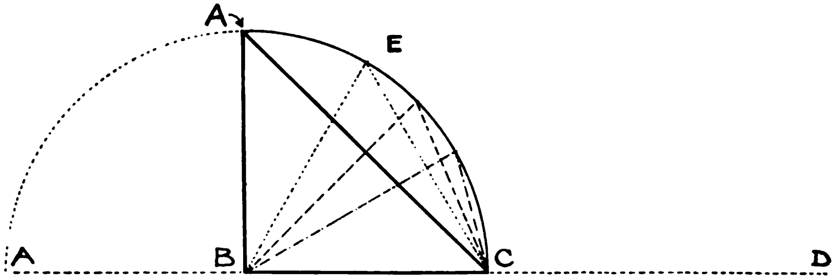


FIG. 1.

Place point B of the tape at the apex of the angle to be laid off or measured, as B in Fig. 1, and place the point C of the tape at a point C in the base line adjacent to the quadrant in which the angle lies. With these points fixed, swing the free end of the tape AB until it lies in the line whose angle is to be measured as BA¹. From the end of BA measure the angle by reading the mark on the tape at which the chord CA¹ terminates, in this case 90°. For the angle C B E, the chord C E will read 60° on the tape.

To provide a tape which will be useful to measure angles in two quadrants, I have made use of the polar equation of an ellipse referred to a focus to determine the length of the radius vectors of an ellipse. These being calculated and marked upon a face of the tape constitute what may be called a scale of radius vectors, which occupies the central portion of a tape of which the end portions may be blank. This tape may be graduated so as to be used in two ways. The entire tape may form the three sides of a triangle, one side of which is in the base line, or in the major axis of an ellipse from one of whose focii an angle is to be measured, as in Fig. 2. Or the entire tape may be the two free portions, or the radius vectors of an ellipse with the two ends A and B held at the focii A^1 and B^1, in Fig. 3. In either case the method of use is the same after the proper focii are obtained and the proper points of the tape secured at them.

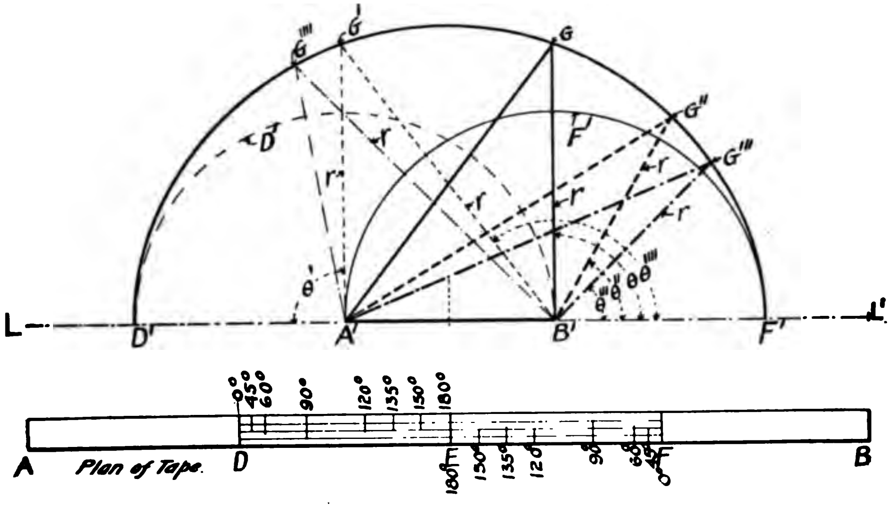


FIG. 2.

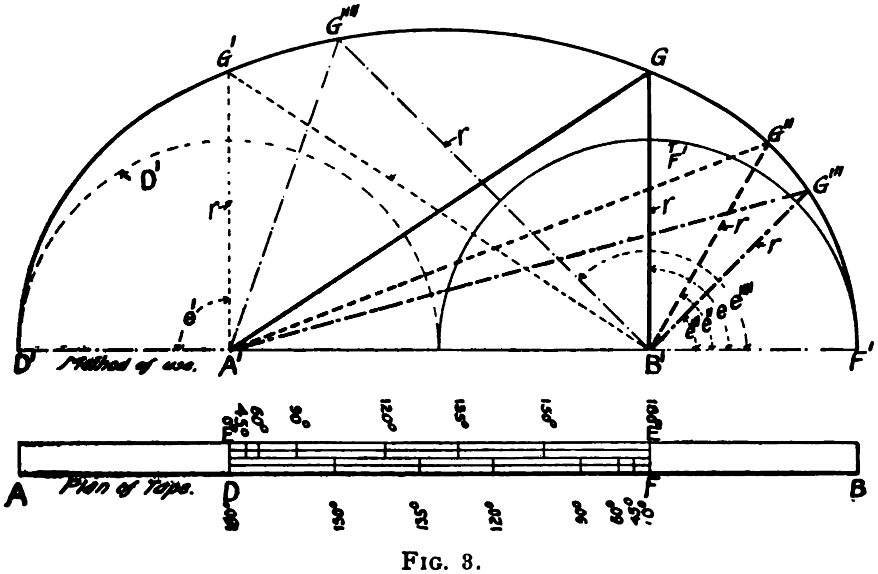


FIG. 3.

Let us suppose it is desired to measure an angle from point B^1 in Figs. 2 and 3. In the case first mentioned, where the tape constitutes three sides of a triangle, place the ends A and B on point B^1 and hold them there, then hold D at A^1, a point in the base line a distance A D or F B to the left of point B^1. Now take the free portion of the tape and proceed in the line whose angle is to be measured, so far that the free portions are taut. The graduation on the tape now in the line to be measured shows the angle—in this case 90°. Similarly, any angle between 0° and 180° may be read directly on the tape, thus providing for both quadrants. It will be readily seen that it is possible to measure angles from a left-hand focus in a similar way by using the scale D E^1, which is placed upon the tape only as a convenience, as it is similar in every way except direction to F E. In Fig. 2 A^1 B^1, or the distance between focii, is shown as 25% of the length of the tape, but it may vary between 0 and 50%. In Fig. 3, A^1 B^1, or the distance between focii, is shown as 50% of the length of the tape, but it may vary between 0 and the entire length of the tape. To avoid the necessity of having a man to hold the tape at each of the two points in the base line, I have designed a surveyor's pin, which is fitted with a tape-holding device.

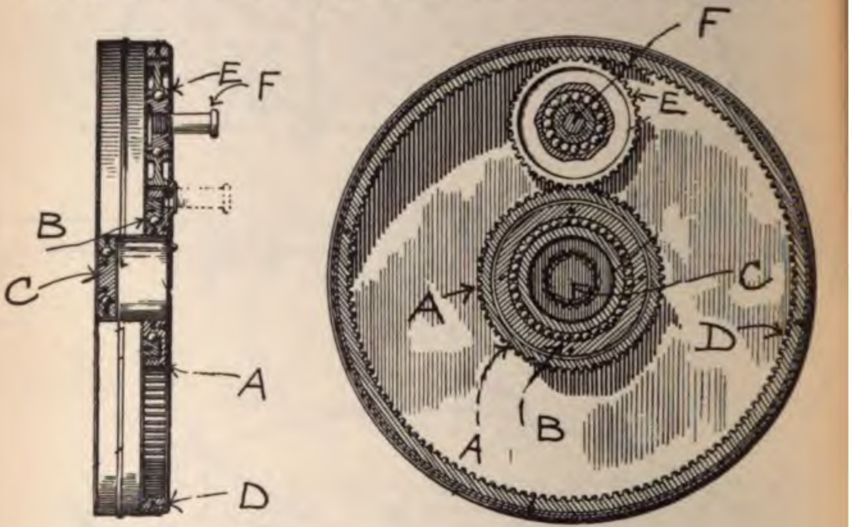


FIG. 4.

In Fig. 4 is shown a new style of tape case, made in two compartments, one holding a tape wound upon the hollow hub and the other containing the mechanism for turning this hub and winding up the tape. To the hollow hub is attached a gear wheel A which revolves on ring B, which forms a bearing for the right-hand end of the hollow hub, as shown in the cross section. To the left-hand end of the hub a ring is attached, which ring revolves around C, thus forming a bearing for that end of the hub. Around the outer rim of the machinery compartment is the cogwheel D E and between D and A is a wheel E, meshing with them, and running free. When E is rotated by turning handle F and the wheel is caused to make one complete revolution around the hollow hub as an axis, the cogs in E will have traveled over a distance of about 310 mm.

This peripheral motion is communicated to the circumference of wheel A, whose circumferential measurement is about 124 mm. Consequently, A will revolve 2½ times while E makes one revolution, which will cause the tape to be wound up 2½ times as fast as with the ordinary form of tape-case. A higher ratio can be obtained if desired.

A man handling the case can wind up a tape as fast as the man at the other end can walk. Thus he will make a practice of keeping the tape in the case, and not looped up, by which latter practice more damage is done to tapes than is done by all the legitimate wear to which they are ordinarily subjected in their use. It will be seen that the case is not made objectionably thick by the addition of the extra compartment, and it may be easily taken apart for repairs of tape or to insert another tape.

CONCRETE ON THE FARM.

BY LLOYD Z. JONES: (MEMBER).

The time seems to be at hand when a more permanent method of construction of farm buildings must be used. Land worth $40 per acre that produced a crop that sold for $10 to $25 per acre could easily buy new lumber at $15 per 1,000 ft. But now, the same land, worn and aged, worth $100 to $150 per acre, and producing a crop worth $10 to $20 per acre, must find a cheaper and more durable building material than lumber at $25 per 1,000 ft. Any pretense at permanency on corn land farms will generally be found to be a soft-brick wall laid up with lime mortar and standing only because the load it carries holds it in place. The unexposed portions might as well have been laid with clay mortar. My father's blacksmith shop chimney, on the farm, laid 25 years ago with clay mortar, is as good to-day as it was the day it was built up to the roof. During the same time the brick house has been painted several times and the basement walls concreted to keep the bricks together. Lime mortar has a proper use in thin masses free from damp. Natural cement has its uses where its quick-setting property is the desirable consideration.

Portland cement is coming to be the universal building material. Combined with iron beams, rods and wires it builds anything. With Portland cement the worthless sands, the gravel banks and the boulders are turned into gold or its equivalent. The artificial stone or concrete age is now with us. Some of the limitations and possibilities of the future wood supply may be seen in sections of fence post timber in my possession; one is from a cedar post 4½ ins. diameter, which grew 176 years, and required 96 years to grow a ring an inch thick. Another cedar past, grown in 190 years, was a young tree at the time of Louis XIV. of France, Charles XII. of Sweden, Queen Anne of England and Frederick William of Prussia. These posts last but a fraction of the time it takes them to grow. A section of an oak railway tie shows 40 years required to grow an inch wide, yet it is damaged to uselessness in five years, above ground, set as a guy rope post. Other samples of osage orange, mulberry, catalpa and black locust grow from ½-in. to over 1 in. in diameter each year, and if seasoned for two years will last 20 to 100 years. The future wood supply is an engineer's problem, the serious nature of which is compelling a change from wood to concrete construction.

In trying to discuss the use of concrete on the farm I have found many difficulties, including the limited use from which to cite examples and the great variation in prices of the same material: Cement,

$4 in a country town, $2 in a large city, and $1.60 by the carload; gravel $1 per yd. in the city and $2 in the country. Sand and coal each cost 7 cents per bushel. In sections where there is no sand, gravel or stone, concrete will cost the higher prices, cement $2.25 to $2.60 and broken stone $2 per yd. But the owner of such land can offset his rich land against some other man's sand and still be ahead. In other sections where sand, gravel and stones can be had for almost nothing, the cost of concrete is small. In concrete cost on farms I have charged nothing for labor. The farmer gets his living for his time. Many of them have homes and grounds and conveniences that would cost them $50 per month rent in a city, not to mention an endless supply of fruits, vegetables, eggs, poultry, milk, cream, fresh meats, and bacon and hams, home cured, from the finest animals grown on the farm. He has, in fact, a living that would cost him $2,000 per year. Hence no labor cost of himself and help while working concrete.

Concrete is cheap only by dilution and dilution is in proportion to the thickness of the work. The following comparative table is based on cement at $2, sand 7 cts., gravel $1, and broken stone $2 per yd.:

	Material Bbls.	Cost per Yd.	Cement Cost per Yd.
(1) Neat Portland Cement....	7½	$15.00	.....
(2) 1 Sand, 1 Cement....	Sand 4½ Cement 4½	9.90	$9.00
(3) 2 " 1 "	" 6 4/10 " 3 2/10	7.70	6.40
(4) 3 " 1 "	" 7½ " 2½	6.50	5.00
(5) 2 yds. broken stone + No. 4	....	5.25	4 50
(6) 2½ mixed " " + No. 4	....	4.60	4.00
(7) 3 yds. gravel + No. 4	....	3.15	1.66
(8) 9 yds stone, 3 yds. gravel, + No. 4.......... ..	....	1.05	.55

The second column is the farmer's cost price if his farm produces all but the cement. No. 4 is the unit of measurement. It will hold no more sand and no more cement. Nos. 5 to 8 are dilutions and depend upon the amount of large material that No. 4 can be made to fill. Where No. 7 is used in work 4 ins. thick, if round pebbles less than 4 ins. diameter are pounded into the work the cost will be lessened about half. The large stones used in No. 8 reduce the cement cost to a small amount; No. 8 will dispose of all the unsightly stones, bricks, over-burned waste at the brickyards and even the broken crockery and dishes. No. 4 costs 2 cts. per ft., 1 in. thick. The proportions of voids are as follows: Broken stone or spalls, 50% each; round pebbles and mixed broken stone, 40% each; gravel and sand, 33% each. The above formulas for mixtures cover the whole demand, from washing hair cracks in a cistern to the heavy foundation wall.

We will now consider the application of concrete to farm construction.

Concrete siding for dwellings and other buildings; also to renew old buildings having good foundations and frames, but an outward appearance not in harmony with their surroundings. Procure poultry netting, 1 in. mesh, 4 ft. wide. If a new building, sheet it with rough No. 2 or cull lumber. Put up a breadth of wire, staple it at top, bottom and one side and stretch sideways. Drive screws into the wall, leaving the heads out ⅜-in. Put the wire in the slot in the screw and drive a staple over to hold it in place. The screws and staples keep the wire out from the boards and carry the load. If the building has old siding, no screws will be needed. Plaster with Portland cement mortar No. 4, and keep it wet, not dripping, until set. A dwelling plastered in this way and filled between the studding with sawdust, makes a most comfortable home, if the housewife is pleasant tempered. It never needs paint, and vines and creepers take to it readily and do no damage. It costs 3 cts. per sq. ft. If sided with lumber the cost is 5 cts. per ft.

Cement roofing also needs no screws. The first coat is spread on about ⅜-in. thick and when the cement begins to stiffen, 1½ or 2 in. netting is spread over the concrete and staples are driven down through the first coat and the second coat spread on. To guard against leaks, the roof should be put on in 4 ft. breadths up and down the roof and a strip of wood, ¼x1½ ins., put between for an expansion joint. The cement of the second coat can be raised ½-in. at each edge to keep out water. Nails can be driven down the ¼-in. strip into the sheeting and a cap strip of cement cast over the joint and held in place by the top ends of the nails. This work should be done late in the afternoon and kept damp by a wet blanket. Cost, 3 cts. per sq. ft. Shingles cost 3½ cts.

In concrete house construction the foundation should be a little wider than for brick walls, to guard against cracks, which look much worse in a concrete wall. There is a tendency in walls to settle more under the parts solid from base to cornice than under the parts where there are openings for doors and windows, which is shown by diagonal cracks from the ends of window sills up to the window opening. Extra wide foundation should be laid outside at each corner, as corners of buildings frequently settle more than the sides and a crack will start perhaps a dozen feet from the ground and run diagonally down each wall from the corner, so a large piece of base and building are detached. I have observed these cracks in brick and stone buildings and would try to avoid them in concrete.

For a two-story and basement house, a 10-in. wall is thick enough. A piece of 2-in. iron pipe, two or three feet longer than the width of the window and door openings, should be embedded above and below each opening, and two pieces of pipe screwed into an elbow and laid in the corners would help tie the walls together.

Dovetail shaped strips sawed from 2-in. lumber should be laid in the walls, 20 to 24 ins. apart, from basement to cornice, to nail to, so the walls can be stripped and plastered with an inch of dead air space between. You cannot make a home of any place where the cold of winter and the heat of summer can follow the solid wall clear through to the inside. Dovetailed wood-bricks should be placed next door and window openings. If chimneys are wanted in outside walls they can be thickened outside or inside and a taper form be used to form the chimney and raised with each rise of planks. All plank forms should be planed and always be carefully placed, as saw marks and knots on planks and bad joints show plainly in concrete.

The lower course of plank should be removed as soon as the concrete is well set, so that any imperfections in the wall can be corrected while the concrete is yet soft enough to scrape and smooth. Any patching must have the same percentage of sand as the filling of the wall. The plank forms may have strips nailed to them so the face of the wall will show like blocks of stone.

For the facing, using a mixture of 1 cement to 3 of sand, mixed sizes of sand preferred. Do not use sand from limestone formations if you can get granite sand. Place some of this cement mortar next to the outside planks and fill in behind with the regular concrete. Do good work; the best of plans and specifications count for little if the mixing and placing are not well done by the last man on the job. In cities, often the front wall only is built for looks, but generally all sides of a house will need to be carefully done.

Plank forms can be held together by bolts and kept apart by taper sleeves of wood, 3 ins. to 2½ ins. diameter, as long as the thickness of the wall, with holes through the center for the bolts. Half the diameter of bolt and sleeve is against one set of planks and half against the next set above. As the forms are raised the sleeves can be driven out by a wooden punch the size of the small end. The holes can be used to support scaffold, but should be filled as soon as possible, while the wall is yet green. Regular concrete builders should have a complete set of iron form holders, which hold all angle work, as well as straight wall.

Iron bolts should be placed in the work with the thread end projecting where desired to hold woodwork, and perhaps the better way to place joists would be to put in a row of bolts and build the wall solid and then bolt on a timber to carry the ends of the joists. If the inside should burn out, the walls might be enough stronger to not be destroyed.

Concrete building is the coming new and good trade. The ordinary mason knows little of cement and concrete and the College of Engineering at the University of Illinois could not do the State of

Illinois more speedy good than to organize a Short Course in Concrete Construction, and send out to the cities and towns for the masons, contractors, builders and engineers to come and learn. It would rival the Short Course in Agriculture, with its increasing hundreds of attendants in several States. If held in the later part of January it would have the additional advantage, as the men are not busy.

To concrete a well, dig down about 4 ft. for the regular 3 ft. 4 in. size. Lay up with hard bricks and concrete the inside carefully with a coat an inch thick. Then dig the well 32 ins. diameter, and plaster it with cement mortar as fast as dug, digging foot-holds in the walls and cementing them also for a permanent ladder. By using a wash of natural cement, which sets in 3 to 5 minutes, a great depth can be sunk in sand or other bad material, the wash holding the wall in place while the cement mortar is spread on. This method has eight good reasons for its use: 1, About a third less dirt to remove; 2, A small well is less liable to cave; 3, The well can be dug in sand to great depth and be safe; 4, 70 bricks per ft. cost 50 cts., cement costs 15 cts. per ft.; 5, Saves troublesome wooden curbing; 6, Allows safe expansion into jug form if water supply is small and on a low level; 7, The pump may be cemented in at the top and its suction increase the flow of the vein; 8 (depending on 7), No chance for local pollution; no disease germs possible unless they come in the underground water.

In building storage reservoirs on stock farms a site should be selected, if possible, so that all the water pumped shall pass through a small tank in the kitchen. The tank will then contain the freshest water pumped. The same in the milkroom. Thence the water goes into the storage reservoir at the top level, so no backwater will come into the house. The reservoir should be shallow, the bottom high enough to drain dry to the highest stock supply. The diameter should be such that at least a four days' supply of water will be stored, as I have several times known a windmill to stand still four days in hot weather. The daily water supply for stock is about 5% of their weight, although the head of the herd may come to a tank and take out 200 lbs. of water. The overflow should pass back to the well and empty into a leaky pail hung to the pull-off wire of the mill; or, if governed by a float, it should be large, of light wood boiled in paraffin, and adjusted to act quickly.

With a large storage reservoir, all stock drinking troughs should be as small as possible to accommodate the stock depending on each, so that less water will be exposed to heat and cold. A 1 in. supply pipe is not large enough where a large number of cattle are brought to drink. More care is used in water supply for stock than has been customary heretofore, as they have keener sense of smell and taste than man and are sure to drink at the best supply. A herd of cattle will wade a stream to go to a well tank to drink. In firm soils this storage reservoir can be cemented directly on the clay of the bottom and sides. The dome should be made of brick laid in lime mortar, as cement does not lend itself so readily to the building of arches. The dome should be cemented outside and inside and covered with earth sowed to grass. Frost does not go deeply under grass. The drinking tanks should be made with rounded inside corners and sloping sides, so ice will not break them.

In building silos, the essential is that they be airtight on the sides and bottom. Concrete is the best known material. It is airtight and the products of fermentation do not destroy it. Silos should always be circular in form unless built to fill a given space. The engineer's rule for greatest capacity with least material does not apply, as silage requires great depth and an area such that the daily consumption will take off a layer of feed over the whole top. The foundation may be let down into dry earth 4 ft. and the earth all removed, thus giving additional depth. No bottom is needed. The bottom course of the wall should be 2 ft. wide and the thickness may be quickly reduced to 6 ins. Large wires should be laid around in the walls sufficient to withstand the thrust of the silage, which (although not like water) is considerable when the silo is first filled, and almost nothing when the fermentation has begun. An extra number of wires should be laid just above and below each one of the feed doors, as these doors will take out about half of the wall from the ground to the top.

In building concrete feeding floors a trench 6 ins. wide should be dug around the area, about 2 ft. deep, and tamped full of concrete. If any filling has to be done to get the proper grade, a temporary fence should be placed around outside and stock yarded on the area to tramp it solid. Build in 4 ft. squares, 4 ins. thick, separating the squares by strips of thick tar paper. Sand or ashes may be used or the concrete laid directly on the ground. Rats must never be allowed to get under this floor, so a trench should be dug down to the bottom of the curb and a ledge 6 ins. wide and 2 ins. thick be laid clear around the curb and the trench filled. When a rat digs down to get under he will think he has come to bed-rock and stop. This trick is useful around cellar walls to discourage rats. Similar construction should be used for cattle, horse and sheep barns.

A concrete floor will be a hog's delight in summer and his death in winter. He never does well sleeping on a floor in winter time. He is more like man than any other domestic animal. He wants a bed under him and a blanket over him. So his sleeping place should be concreted to keep it dry and then have a foot of dry earth put in for a bed. It should be made a foot lower than the feeding floor, with a curb a foot higher than the feeding floor for him to climb over. Then his bed and straw bedding will not be rooted over the premises in his endeavor to follow his instinct to keep his bed dry and clean.

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All concrete floors for animals should be rough. No smooth coat is needed. For 1,000 sq. ft. of concrete feeding floor the cost is $38 down to $12; plank, $60, and brick $44. Use no ashes under a brick floor. If by chance a brick should come loose the hogs soon root up the whole floor to get out the coal in the ashes.

Fence posts can be made of concrete. They should be about 2x4 ins. at the top, 4x6 ins. at the ground, and 2x4 ins. at the bottom in the ground. A form can be made with loose partitions and a dozen posts be cast at one time. Slight projections at proper intervals space the wires or boards which are fastened to the posts as telegraph wires are fastened to the glasses. A straight piece of barbed wire embedded in each corner strengthens the post. They cost about 20 cts. each. Pier posts; top 8x8 ins.; bottom, 16x16 ins., and 12 ins. deep, making a cubic foot. These can be cast in a form for 5 to 10 cts. each. A rough stone block of the same size costs 22 cts. There are many uses for such pieces on a farm.

Sewer pipes filled with concrete make the best possible pillars for granaries and similar structures desired to be rat proof. Rats and mice can climb concrete, but not the glazed pipe.

All concrete work on the farm should be solid. The farmer who puts in the popcorn ball or crackerjack concrete of many city sidewalks is only wasting his time and money.

To test cement sidewalks: Inspect them on a damp, foggy day, when they are wet, but the water does not run off. Black ridges of dirt will be seen over each hair crack, even when so slight it cannot be seen when the walk is dry. A better job of concreting can be done with a wet mixture than with a moderately dry one. The cheaper classes of work require a wet mixture to fill the voids and the wet mixture in first-class work will give the air bubbles a better chance to escape than in a stiff mixture. A sample of railway bridge concrete. 1-2-4, material cost $5.85 per yard, shows many air bubbles that could not escape. It is probably not so strong a concrete as concrete 1-3-6, cost $5.25, would have been with the same kind of mixing.

Another specimen, broken from a farm cellar floor to make room for a heater, made of fine bank gravel, shows voids in the concrete and a multitude of fine air bubbles in the smooth coat. I present this problem to the young engineers: How shall we mix concrete so it will contain no air?

In discussing this subject, no mention has been made of a job for an engineer. We have made the farmer and his men gather up the stones, bones and brickbats, get clean gravel from a bend in the creek, get sand from some hillside, make the mixture and pound it in place with iron rammers, all free of cost. Yet there will be a wide place for the engineer to make the plans, forms, moulds and centers and oversee the work. Do such work that the names and dates will last a hundred years.

Last year when we learned there were over 16,000 students in the engineering schools, I wondered where they would all *get jobs.* This year I wonder if there will be enough men for the many jobs that need educated direction. Two of the smallest examples illustrate the point:

1. A fine park fountain basin, sound when emptied, now frozen into a hundred pieces.

2. A dry summer, grass short and stream water just gone. A green spot was seen on the point of a hill where were found two crawfish holes. A hole was dug into the hill at the green spot and a stream of water the size of a lead pencil ran out and soaked into the ground below. A reservoir was dug, a pipe laid out level into the bottom of a deep trough so no water could waste until trough and reservoir were both full. Result, 70 cattle and 260 sheep were supplied with plenty of water.

DISCUSSION.

PROF. BAKER: I doubt if any of us can fully appreciate the change that is taking place or that may take place in the next few years in the use of cement and concrete. When Portland cement cost $3 to $5 a barrel there was not much inducement to use it except where necessary. But now that the price of the best Portland cement is about $2 a barrel in almost any of the smaller cities, there are many uses to which it is put. It is not impossible that within a year or two Portland cement may sell in carload lots for $1 a barrel in most of the small towns of the United States. When that time comes, many of the things Mr. Jones speaks of in his valuable paper will be possible: cement silos, cribs, reservoirs, etc. I have had two or three letters from farmers inquiring about this very matter, and I know many of them are considering the possibilities of concrete, not only because of its intrinsic advantages, but also because of the rapidly increasing price and decreasing quality of lumber. I think there are rare possibilities in the use of concrete, possibly of concrete and steel combined.

MR. L. CLARK: Last year I was building on one of my farms and I found it very different from what Mr. Jones has stated. They charged me for concrete foundations about three times the price of rough rubble work and about twice the price for smooth coursed work. I could not get a bid on it for less than $3.50 per cu. yd., and I to furnish the lumber for the forms. With reference to stable floors, we prefer brick. Concrete is a little cheaper, but is too slippery, and horses on a brick floor are less apt to strain themselves in getting up and down. But I do think concrete is much ahead of the ordinary mason work we get, but in my locality it costs too much.

MR. JONES: The top coat must be rough. The easiest way to make it rough is to let the gravel stones come to the surface. I was attending a Farmers' Institute at a town last week where the concrete sidewalks were so smooth we could not walk on them. In a case like that I believe they should have been sanded with coarse sand, put on after the concrete work was done.

C. W. **MALCOLM**: A farmer near Mansfield has about 10,500 sq. ft. of concrete laid and is well pleased with the result. It is principally to give a solid floor for feeding cattle in bad weather, when the ground is muddy. In connection with this is a double corncrib, with concrete sills and driveway and a large enclosed shed with a concrete floor. The sills of the crib are about 15 ins. high and are flared at the base to give additional bearing. These sills were made high, so that the floor of the crib cannot easily be reached by rats. The concrete floor is left rough, so as not to be too slippery in wet weather.

To attach the posts of the sheds, hedge posts are imbedded in the concrete. These posts project slightly above the floor surface and have a tongue and groove so that the posts of the shed may be easily fastened and renewed when necessary. All the work was done by the owner without any previous experience with concrete. He was able to arrange with a railway company for getting broken stone and gravel, of which they had a surplus. On this account the cost was only about one-half what it could have been contracted for.

MR. NICOLET: A large amount of work can be materially cheapened by increasing the proportion of sand. In unimportant work it may be increased to 1 to 4½ or 1 to 5.

MR. JONES: I have thought about thick walls, if we would put wooden blocks in the right place in them, they will take up room, and it would do just as well as if it was all concrete.

MR. NICOLET: I would not advise anybody to attempt to put wood in concrete. It would almost surely result in failure, for the reason the blocks of wood would absorb the moisture and crack the concrete. But concrete does not make a dense mixture. It is almost impossible to build a concrete wall, two feet thick, 1 to 5, and get it watertight. A great many experiments have been undertaken along that line. In order to get a dense mixture you have to use about 1 to 2½. One to 4, of course, is a cheaper mixture.

MR. JONES: The difficulty is probably in the practical mixing of the material. To get a good job it should be done on a machine, I suppose. I had a sample piece taken out of a farmer's cellar, which I soaked in water and then tried to freeze. It has air holes through it, but I have not been able to freeze it.

MR. NICOLET: I find a great deal of good in tamping thoroughly. In some important work we started out with a 30-lb. tamp and found that unless the men put some force on the tamp we did not get a solid mixture. The weight of the tamp was increased to 50 lbs. The men simply had to lift and drop it. Then we got a very solid and dense mixture. I have a great deal of faith in heavy tamping on a good, solid mass of concrete.

THE PRESIDENT: I have been told by Mr. Benzenberg, one of the consulting engineers on the new Cincinnati waterworks, that they have been using a concrete tamping machine run by compressed air, and have worked it with great success, and it is his opinion that there will be quite a revolution in our ideas of tamping concrete, due to the introduction of machines of that kind.

THE EFFECT OF MANURE ON MASONRY AND CONCRETE.

BY LESLIE A. WATERBURY (MEMBER).

About a year ago the "Engineering News" gave considerable space to the discussion of the effect which manure, used to prevent freezing, has upon concrete. Some writers thought that concrete is weakened or rotted by manure, especially if rained upon so that the water passes through the manure and penetrates the concrete. With the hope of determining something concerning the matter, the writer has undertaken a few experiments.

Three sets of briquettes were made of neat Portland cement. At the end of one day one-third of the first set were placed in water, one-third in horse manure flooded with water, and one-third in cow manure flooded with water. The briquettes set in water were to serve as a standard by which to compare the others.

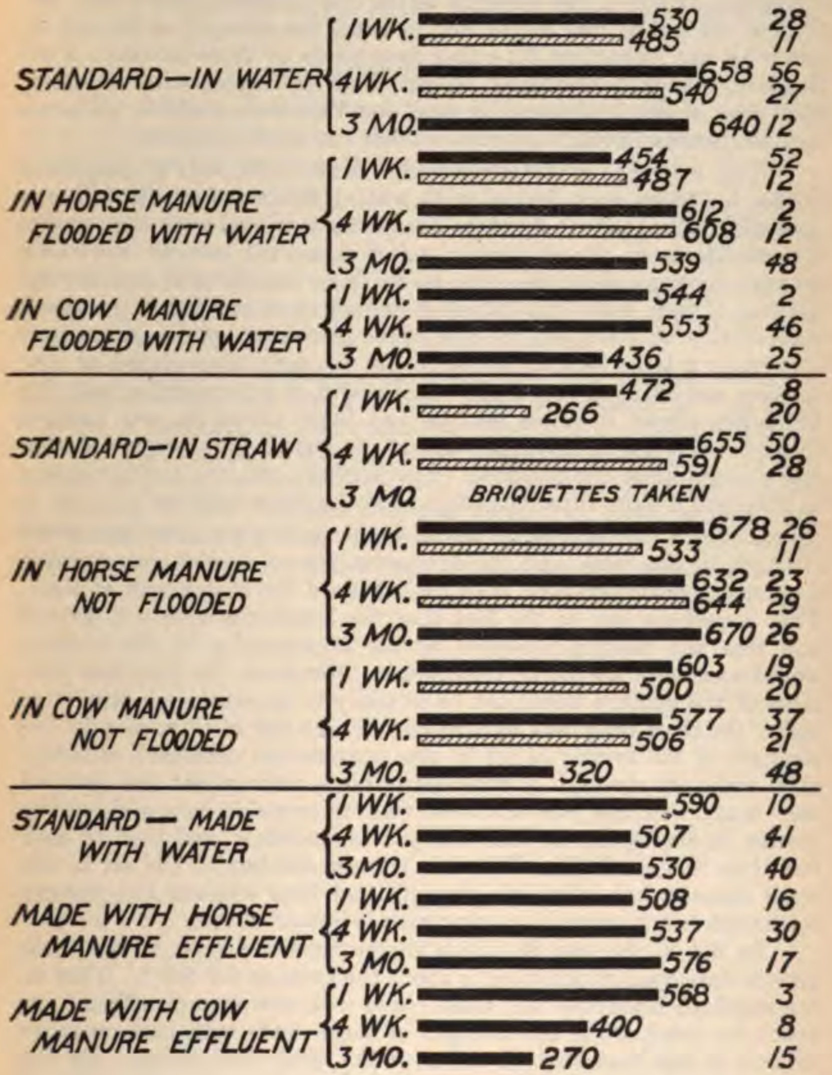
When the second set of briquettes was taken from the moulds at the end of one day, one-third of the number were placed in clean, moistened straw, one-third were covered with horse manure and the other third were covered with cow manure. The briquettes set in straw were to serve as a standard for this set. In this case none of the briquettes were flooded with water.

One-third of the third set of briquettes were made with clear water for the mortar, one-third with the effluent from saturated horse manure instead of water, and one-third with the effluent from saturated cow manure. All the briquettes of this set were placed in water at the end of one day.

Briquettes from each group of each set were broken at the end of one week, four weeks and three months. The mean tensile strength for each case is shown graphically on the diagram by the length of a heavy black line and its value in pounds per square inch is also given.

Some of the experiments were repeated, but in this case there was not sufficient time to permit tests at the end of three months. The results of these experiments are shown on the diagram by the lighter lines.

The column of figures at the right edge of the diagram gives the probable error for each result as determined by the approximate formula $Em = \frac{0.8453}{n\sqrt{n-1}} \Sigma d$, in which d is the difference between any observation and the mean and n is the number of observations. The probable errors are all large, which indicates that the amount of the breaking load was very irregular for each group.


STANDARD—IN WATER
1 WK. 530 28
485 11
4 WK. 658 56
540 27
3 MO. 640 12
IN HORSE MANURE FLOODED WITH WATER
1 WK. 454 52
487 12
4 WK. 612 2
608 12
3 MO. 539 48
IN COW MANURE FLOODED WITH WATER
1 WK. 544 2
4 WK. 553 46
3 MO. 436 25
STANDARD—IN STRAW
1 WK. 472 8
266 20
4 WK. 655 50
591 28
3 MO. BRIQUETTES TAKEN
IN HORSE MANURE NOT FLOODED
1 WK. 678 26
533 11
4 WK. 632 23
644 29
3 MO. 670 26
IN COW MANURE NOT FLOODED
1 WK. 603 19
500 20
4 WK. 577 37
506 21
3 MO. 320 48
STANDARD — MADE WITH WATER
1 WK. 590 10
4 WK. 507 41
3 MO. 530 40
MADE WITH HORSE MANURE EFFLUENT
1 WK. 508 16
4 WK. 537 30
3 MO. 576 17
MADE WITH COW MANURE EFFLUENT
1 WK. 568 3
4 WK. 400 8
3 MO. 270 15

Another respect in which these experiments were unsatisfactory, is the manner in which the standard briquettes developed their strength. In Set 1, the strength at the end of three months was less than at the end of four weeks, and in Set 3 the strength at the end of one week was more than for either four weeks or three months. Furtherfore, standard briquettes of Set 3 do not agree with standard briquettes of Set 1, although in each case they were made in the same way and were allowed to set under about the same conditions.

With reference to the effect of the manure, the tests of briquettes of Set 1 (which were flooded with water) indicate that mortar covered with horse manure develops less strength in one week than under the conditions of the standard, and that mortar covered with cow manure develops about the same strength as that in clear water. By the end of four weeks the standard briquettes of Set 1 had increased considerably in strength, the briquettes placed in horse manure had also made a large gain in strength, but the briquettes placed in cow manure had changed very little. By the end of three months, both the briquettes placed in horse manure and those placed in cow manure showed less strength than they had at the end of four weeks and also less strength than the standard. Furthermore, the cow manure seems to have had a more injurious effect than the horse manure.

In Set 2, the briquettes placed in horse manure developed great strength in one week and the briquettes placed in cow manure also developed greater strength than the standard for that length of time. This is perhaps due to the fact that the briquettes were not flooded and that any heating produced by the fermentation of the manure would accelerate the set of the mortar. Moreover, the injurious portions of the manure would not be so likely to penetrate the briquettes before the short time tests were made. By the end of three months the strength of the briquettes set in cow manure had decreased considerably, while the strength of those set in horse manure had not changed very much. In this case the horse manure seems to have assisted the mortar in developing its final strength immediately, and then to have left it in that condition. The cow manure accelerated the set in the same manner, but after this strength had been attained the manure continued to act upon the mortar with injurious effects.

In Set 3, the way in which the strength for each of the three groups developed in one week is about the same as for Set 1. That is, the standard briquettes and those made with cow manure effluent are about the same, while the strength of those made with horse manure effluent is less than that of either of the other two groups. By the end of three months the briquettes made with cow manure effluent had decreased greatly in strength, while those made with horse manure effluent had about the same strength as the standard.

In all cases the cow manure ultimately had a more injurious effect upon the mortar than the horse manure. This might not have been the case had the briquettes been removed from the manure at the end of one week, but no experiments were made in this manner.

The cement used for all of the tests was Atlas Portland cement.

DISCUSSION.

MR. JONES: I understood these sidewalks that were destroyed were destroyed by hot horse manure, where it was fermenting. I had an idea it was the ammonia that caused the injury.

MR. WATERBURY: The fermenting did not seem to decrease the strength, but the heat seemed to accelerate the setting. No briquettes which had first set for some time, were placed in the manure. If the ammonia in the manure would affect the cement, it would possibly be shown by taking the briquettes which had already set and placing them in manure. No such test was made in this case.

MR. NICOLET: Perhaps the cement was not properly covered; that the covering was not sufficient, and that because of the large amount of moisture in the cement the frost might affect the cement through the manure. I have seen no bad effects as yet from manure coming in contact with cement. Last winter we used a large amount of manure to cover concrete that was exposed to frost, without any deleterious effect whatever. I think where the cement goes to pieces it is because of the frost rather than from contact with manure.

NOTES ON CONCRETE.

DISCUSSION.

MR. NICOLET: I have used a great deal of gravel concrete. My first experience dates back 22 years ago. All through my practice I have used it, and I have never had any trouble except where there was considerable soft rock in the gravel. Soft rock, of course, will absorb the moisture, and go to pieces, or sometimes crack where it is not sufficiently covered. As to the use of gravel compared with broken stone, I think it is a question of whether you want the greatest strength possible in the concrete, or whether you simply want an ordinary structure; then it becomes a matter of the relative cost of broken stone and gravel. Undoubtedly a good, sound gravel makes a most excellent concrete, and I have never known a failure from it.

In the use of broken stone in concrete there is another related matter, namely, the use of limestone screenings instead of sand. I have made a limited number of experiments with screenings, using them in proportions of 1 to 3, 1 to 4 and 1 to 5. The 1 to 3 mixture gave usually a higher tensile strength than the neat cement at the end of a year, namely, about 800 lbs. per sq. in. The 1 to 5 gave between 300 and 400 lbs. Tests were also made to determine the effect of the stone dust, that portion passing a No. 50 sieve being classed as dust. Briquettes having 10% dust showed only about 20% more strength in one year than those having 30% of dust in the screenings.

THE PRESIDENT: This subject of the use of screenings in cement was exhaustively discussed by a commission on the Jerome Park Reservoir, New York, in which the engineer substituted screenings for sand.

PROF. BAKER: Concrete made of broken stone is considerably stronger than the same proportion of a gravel mixture. I presume the reason is because the cement adheres better to the rough surface of the broken stone than to the smoother surface of the partially rounded pebbles.

MR. TRATMAN: Mr. S. B. Newberry has recently written a paper in which he claims greater strength for gravel concrete, as good quartz gravel is harder than stone (except for trap or quartzite), and its rounded form leaves less voids. There is no ground, he says, for the belief that rounded stone or sand makes concrete of less strength than that made with angular material.

MR. SCHRADER: The engineer generally bases his opinion as to the desirability of concrete and its component parts on laboratory tests of strength. An important consideration sometimes lost sight of is *durability*, especially for exposed surfaces. Limestone dust and very fine screenings of limestone do not seem to me desirable in concrete for exposed surfaces, on account of the amount of moisture it will absorb and the consequent deterioration due to freezing and thawing. Good, coarse, clean sand or better still, good granite screenings, would seem to be preferable for the purposes and reasons mentioned. We do not use gravel for concrete work to any considerable extent in Chicago, as we have excellent crushed stone at our door. I see no objection to the use of gravel for concrete, provided it is of suitable sized pebbles and is clean and free from clay or earth, and the stone firm and durable.

MR. JOHN W. CROWLEY: The Chicago, Burlington & Quincy Ry. is building a 63-mile cut-off in Missouri from Old Monroe to Mexico, and last season my company had the contract for all the concrete work on this line, with the exception of the Cuiver River bridge. Our contract included all piers, abutments, box and arch culverts. All the culverts were of the concrete-steel construction, the St. Louis corrugated bar being used. Along this right-of-way is located some very good gravel in the creeks. I suggested that this be used in the concrete, and objections were made to its use in the steel concrete; the reasons being that gravel did not show as strong an adhesion as stone in conjunction with steel. I am an advocate of gravel for concrete, where good gravel can be found, and have used it in construction with very good results; but I have never used it in concrete-steel work and did not remember reading of any tests on this class of concrete. The only information I have been able to get concerning such tests, was from Mr. Johnson, Civil Engineer, of the St. Louis Expanded Metal Co. He informs me that he has made some very satisfactory tests with gravel in his concrete-steel. I would suggest that members, should opportunity present, make some tests along this line, and report at the next annual meeting. There are good reasons why these tests should be made, and that is, to determine what the difference is, if any, relative to the strength of gravel or stone in concrete-steel. To illustrate: On this piece of construction my company is doing, the railway company pays a price per cubic yard per mile haul on all material. Now, in some cases we were compelled to haul crushed stone as great a distance as five miles to the work, when in most cases we could have secured good gravel inside of one or two miles. This added to the cost of construction. We were given the privilege of using gravel for piers and abutments and also completed two 5x7-ft. box culverts; in these were used the steel bars. There is also a heavy fill over both these culverts and I hope to be able to get some data as to the result of the gravel used and will endeavor to report at the next meeting.

The standard plans used for all the concrete-steel box culverts was from 4x4 ft to 5x7 ft. opening. The foundation was 18 ins. thick; side walls, 18 ins. thick; top wall, 12 ins. On 8x8 ft and 10x10 ft. opening, the foundation was 18 ins.; side wall, 3 ft.; and top wall 18 ins. thick. It is claimed that by the use of the steel bar, the saving in quantity of concrete is about 25%. Now, while this may be true, there is this to be considered—that for this class of construction, the increased cost of the work is approximately 25% more than in straight concrete. I have reference to the small steel box culverts. The steel used in larger structures, would be less in proportion. The vertical bar used in those box culverts was the most objectionable in the construction. The longitudinal and transverse bars, while increasing the work, were not so noticeable as were the vertical bars; the latter were only 3 ins. from the face of culvert wall, making it almost impossible for the men working in the forms to secure a good finish. The class of concrete used on these concrete-steel box culverts was a very wet mixture, so wet that the men working in the molds wore rubber boots and stood almost knee deep in the concrete. From what experience I have had with concrete-steel, I am convinced that by the use of steel the quantities can be lessened; thereby, lessening the total cost of construction and, again, it will secure a much better and stronger concrete.

PROF. BAKER: The last speaker referring to the use of steel in concrete by railways calls to my mind a specimen of work by the Wabash Ry., near Monticello. On that work they used a wash made of what they called cream of cement. I saw it after one of the abutments had been completed, and it looked almost as if it had been built of marble. The wash consisted of one pint of plaster of paris and three pints of Portland cement in an ordinary wooden pail full of water. It was applied with an old broom or a stiff paint brush, care being taken to apply it crosswise of the lines left by the joints in the wooden forms. This wash produced an astonishing result, both in making it smooth and in making it white after the cement had set.

PRESIDENT ALVORD: I think one of the great drawbacks to the use of concrete in construction, is its disheveled appearance after it is finished, and some improvement ought to be discovered to give concrete an appearance in keeping with its economy, strength and durability.

CONCRETE FOUNDATION AND CEMENT FILLER FOR BRICK PAVEMENT.

BY O. L. GEARHART: (MEMBER).

In this paper it is proposed to discuss the economic relations between concrete foundations of different compositions and the advantages of cement filler for brick paving.

THE CONCRETE.

About a year ago the writer made a series of experiments to determine the variation in the strength and cost of concrete due to a variation in the kind of cement and in the proportions of the ingredients. The former practice was to use a natural cement concrete for the pavement foundation, but on one occasion a concrete consisting of 1 part Portland cement and 9 parts fine gravel, was used with excellent results. This led the writer to give the matter of Portland cement concrete further study.

The number of specimens made were about as follows: 25 8-in. cubes, 25 6-in. cubes, and 25 beams 6x6x21½ ins.; 11 different proportions with Portland cement and one proportion with natural cement were used. An 8-in. and a 6-in. and one beam were tested after 30 days and 90 days. The different specimens were made by the writer at the Champaign city laboratory, and through the kindness of Prof. A. N. Talbot, were tested on the machines belonging to the Department of Applied Mechanics at the University of Illinois.

MATERIALS. The materials used were Atlas Portland cement, Clark's Utica cement, gravel from a pit northeast of Urbana, Ill.; sand from a bank in the same locality, and broken stone from a quarry at Kankakee, Ill. The sand was a fair quality of building sand, containing some clay and having about 30% of voids. Of the gravel, 23% was retained on a No. 4 sieve, 53% on a No. 10 sieve, 71% on a No. 20, and 29% passed a No. 20 sieve. This material contained 21% voids. It will be seen that the gravel contained but little coarse material. The broken stone was a good quality of stratified limestone, crushed so that all of the particles would pass a screen of 2-in. mesh and be retained on a screen of ½-in. mesh. This material contained 47% voids. The stone is bought by weight, and as the freight is quite an item, it is found to be cheaper in Champaign to buy screened stone and fill the voids with a larger amount of gravel than would otherwise be necessary.

The cement was taken from bags shipped to the city for the retail market, and was not a special cement for testing purposes. It will be seen that the Utica cement is a very high grade of natural cement, and that the Atlas cement is a good quality of Portland. The fineness and activity of the cement are as follows:

	Utica	Atlas
Passing sieve No. 50	97.4%	99.6%
Passing sieve No. 100	80.5%	92.5%
Time, mixing to initial set	32 min.	1 hr. 56 min.
Time, mixing to final set	3 hrs. 20 min.	5 hrs. 16 min.

The tensile strength of the cement, in pounds per square inch, is as follows:

CEMENT	PER CENT OF WATER	AGE		
		24 hrs.	7 days	30 days
		lbs.	lbs.	lbs.
Utica	31	80	181	230
Atlas	17	265	710	....

MIXING AND TESTING. The cement and gravel were thoroughly mixed dry, then wetted and mixed into a stiff mortar, after which the dampened stone was added and the whole was turned several times. The mixture was then tamped into the molds by means of an 11-lb. tamper having a face area of 9 square inches. About two or three inches of loose material was placed in the molds at a time and tamped. During the operation a square-ended trowel was worked up and down between the concrete and form, thus bringing the mortar to the sides and corners of the specimen and making it homogenous throughout. In every case only enough water was used to cause a film of water to come to the surface after considerable tamping. The cubes were left in the molds for 24 hours with a damp cloth over them, after which time the molds were carefully removed and the specimens were stored under cloths which were dampened from time to time until the cubes were tested. The concrete beams were made and stored in the same manner as the cubes. In crushing the cubes and breaking the beams, the direction of the force applied was perpendicular to the tamped surface. Immediately before crushing the cubes, the two faces to which the force was applied was plastered with a thin coat of plaster of paris, and a self-adjusting plate was used to distribute the pressure over the entire surface of the cube.

COSTS. In arriving at the cost of the concrete, gravel and sand were taken at 90 cts. per cu. yd.; broken stone, at $1.40; Utica cement, 65 cts. per barrel.; Portland cement, $2; and labor for measuring, mixing, placing, grading and tamping a 6-in. layer of concrete was taken at 6 cts. per sq. yd.

RESULTS. Table No. 1 shows the strength of the cubes and beams and also gives the yield of rammed concrete in terms of the sum of the volumes of the gravel and broken stone. This table also shows the cost per square yard of a 6-in. layer of concrete of the different compositions.

TABLE NO. I.—STRENGTH AND COST OF CONCRETE OF DIFFERENT COMPOSISIONS.

No.	PROPORTIONS (Cement = 1)		Yield in Terms of Volumes of Gravel and Broken Stone	AGE	LOAD ON CUBES Lbs. per Sq. Inch		Average Crushing Strength	BEAMS 6x6x18 Ins.		Cost per Sq. Yd. for Depth of 6 Ins.
	Gravel	Broken Stone		DAYS	8 In.	6 In.	Lbs. per Sq. Inch	Load at Center Lbs.	Modulus of Rupture Lbs. per Sq. Inch	Cents
NATURAL CEMENT.										
1	3	3	....	30	610	540	575	1280	160	......
2	3	3	77%	90	870	470	670	1270	159	49
PORTLAND CEMENT.										
3	5	......	80.4%	30	1750	1565	1657	2700	338	77.5
4	5	......	... .	90	1770	1990	1880	3060	382	......
5	4	4	74 %	30	1500	1365	1432	2440	305	74 6
6	4	4	....	90	2210	1780	1995	5360	670	......
7	6	4	70 7%	30	1180	1170	1175	1800	225	68.6
8	6	4	....	90	1260	1430	1345	1620	203	... .
9	5	5	74.4%	30	2250	1545	1897	2800	350	66.1
10	5	5	....	90	1850	2050	1950	3280	410	......
11	8	4	72.8%	30	890	840	865	1650	206	57
12	8	4	....	105	883	1230	1056	2500	313	.....
13	6	6	76 %	30	1290	895	1092	2550	319	64
14	6	6	....	90	1510	930	1220	3060	383	......
15	8	6	74 %	30	965	570	767	1750	219	56.8
16	8	6	....	115	1425	860	1142	1700	213	......
17	7	7	74 %	30	1240	1365	1302	2100	263	56.6
18	7	7	....	90	1190	1425	1307	2820	353	......
19	8	8	73 %	30	1010	990	1000	1600	200	51.4
20	8	8	....	103	1050	1030	1040	1930	241	......
21	10	10	71.5%	30	530	600	565	1010	126	50.3
22	10	10	....	118	585	......	......	1220	153	......
23	10	10	....	102	......	610	.....	......	......	......
24	6+	6	....	30	1230	780†	1230	1780	223	......
25	6+	6	... .	107	1720	1535	1627	2410	301	......
26	8	16	+70 %	.....	.....	.....	......	.....	......	51

+ Sand. † Defective, omitted from average.

CONCLUSIONS. From the tests given in Table No. 1, it is believed that the following conclusions may be drawn:

1. The cost of Portland cement concrete is about 4% more than natural cement concrete, while the former is 50% stronger. (Tests 2 and 20.)

2. The strength of concrete composed of 1 part Natural cement, 3 parts gravel and 3 parts broken stone, and concrete composed of 1 part Portland cement, 10 parts gravel and 10 parts broken stone, are nearly equal. (Tests 2, 23 and 24.)

3. The addition of broken stone in amount equal to the gravel, without increasing the quantity of cement, materially increases the strength and decreases the cost of the concrete. (Tests 4 and 10.)

4. The increase of the broken stone from 4 parts to 8 parts does not materially change the strength of the concrete, but reduces the cost. (Tests 12, 16 and 20.)

5. The increase of the broken stone from 8 parts to 16 parts does not materially change the cost of the concrete. (Tests 18 and 26.)

About half a mile of pavement having a very lean Portland concrete was laid during the past season under the writer's direction. It was found, much to the surprise of the writer and also to the contractor, that not only the very lean concrete was more easily mixed, but it was more uniform than the very rich natural cement concrete heretofore used. In all respects, the Portland cement concrete is superior to the natural cement concrete.

BRICK BEAMS WITH CEMENT FILLER.

The writer made a number of brick beams by taking paving brick and cementing them together with a cement filler. The beams were 3 bricks long, 3 bricks wide and 4 ins. deep. They were formed by laying the brick side by side as in the pavement, and the interstices were filled with grout, consisting of 1 part Portland cement and 1 part sand. The cost of this filler was 8 to 12 cts. per sq. yd. Table No. 2 shows the result obtained by supporting the beams on knife edges 24 inches apart and applying the load at the center.

TABLE NO. 2—MODULUS OF RUPTURE OF BRICK BEAMS WITH CEMENT FILLER.

No.	NAME OF BRICK	AGE DAYS	DIMENSIONS OF BEAM Inches			Load at Center Lbs.	Modulus of Rupture Lbs. per Sq. Inch.	BEAM 6x4x18 Ins. Span Load at Center Lbs.
			Depth	Breadth	Length			
1	Clinton	30	4	10½	24	1640	351	1248
2	"	30	4	10¾	24	2160	452	1607
3	"	90	4	10¾	24	2660	557	1981
4	Culver......	30	4	11	24	2570	526	1870
5	Poston.....	122	4	11	24	2210	452	1607

By comparing Nos. 2 and 20 in Table No. 1 with No. 3 in Table No. 2, it will be seen that a brick beam 4 inches in depth is 50% stronger than a concrete beam consisting of 1 part natural cement, 3 parts gravel, and 3 parts broken stone, and is also a little stronger than a beam consisting of 1 part Portland cement, 8 parts gravel and 8 parts broken stone. This fact suggests the idea whether it may not be more economical to employ the cement as a filler between the brick rather than using it in the concrete foundation.

The cost of the cement and labor for a 6-in. layer of concrete composed of 1 part Portland cement, 8 parts gravel, and 8 parts broken stone is about 24 cts. per sq. yd. more than that of a compacted layer of gravel or broken stone; and the cost of the cement filler is about 6 to 10 cts. per sq. yd. more than sand filler. Therefore, a brick pavement with cement filler in it is from 14 to 18 cts. per sq. yd. cheaper than brick pavement with a sand filler and with a concrete foundation. And, further, the two forms of construction are of equal strength.

For a pavement on a street which has been cut up with trenches and where the traffic is heavy, the use of the cement filler adds very much to the strength and to the life of the improvement, and the added expenditure for the filler is money well invested. In resident districts where the traffic is not so heavy or constant, a brick pavement with cement filler and a gravel foundation may be constructed with advantage, and the cost of the improvement be considerably less than if a concrete foundation and sand filler be used.

As far as the writer knows, attention has not before been called to the strength produced by the cement filler, nor to the fact that the brick thus filled makes the beam 50% stronger than the use of concrete foundation; and in view of what has been said concerning the merits of the cheapness and strength of the cement filler, to use it in pavement construction is clearly an economical advantage.

For several valuable suggestions, the writer gratefully acknowledges his indebtedness to Professors A. N. Talbot and I. O. Baker, of the University of Illinois.

DISCUSSION.

PRESIDENT ALVORD: The subject of concrete foundations under pavements is an important one. Last year it fell to my lot to make a valuation of waterworks in five cities, and in the course of this work it became necessary to investigate the cost of cutting through the pavements to examine the pipe. A large number of cuts were made, and as a result I have grown exceedingly skeptical about concrete under pavements. About nine times out of ten the concrete was probably no better than macadam, due to carelessness, or lack of inspection, or some other cause. About one time in ten we found concrete worthy of the name, and which would have cost a great deal of money to cut through on the basis we were estimating. The principal problem in concrete under pavement is, how to get honest concrete. I am not at all certain but what honest macadam is a great deal better than a good deal of the dishonest concrete which we now have, because it costs a good deal less, and is apparently just as strong.

MR. NICOLET: Was that natural cement, or Portland cement?

THE PRESIDENT: Both. In Omaha we made 24 cuts in the pavement, and in many cases the concrete foundation was not as good as the macadam foundation, and there were only 6 ins. at that. In other places we cut through 8 ins. of concrete as easily as if it had been macadam. Once in a while we did strike good concrete, which showed what could be accomplished when it was properly put in.

MR. NICOLET: I would not be surprised to find that after a period of years any concrete made of natural cement had entirely disintegrated, because I have never known an instance yet where natural cement has been exposed to frost, that it would not disintegrate. I have gone down 3½ ft. below the surface of the ground and found disintegration through the action of frost. It is not surprising if the natural cement is found to be disintegrated after a period of years under those circumstances.

PRESIDENT ALVORD: That is somewhat novel to me. It had not occurred to me as an explanation. Most of these cases were where the pavement had been down some 15 years.

PROF. TALBOT: We probably all feel that many pavements are made of very poor concrete. Some very poor construction has been done in foundations for pavements. The natural cement concrete in Champaign, however, has been better than the average class of natural cement pavement concrete, both in the material used and in the manner of mixing. The cement has been up to grade, as is shown by the high tensile strength of the Utica cement quoted. And yet there is something connected with the natural cement mortar which does not give good results. The Portland cement gravel concrete foundation, referred to by Mr. Gearhart, put in six or eight years ago, shows a very solid foundation. Cutting trenches exposed a very strong concrete.

What has struck me as unexpected in these concrete tests is that the lean and meagre mixtures should give such high strength. Mr. Jones has spoken about the1-3-9 mixture; but here we have 1-3-8, and then 1-10-10, giving good results, not only in crushing strength, but also in the transverse strength. The second unexpected point is that there was no difficulty experienced in securing good workmanship in mixing it, and that the contractor experienced no difficulty in making these lean mixtures satisfactory to the inspector. The third unexpected item is the great strength given to the pavement structure by the cement filler. It seems to me that such high strength is a strong point in favor of the use of this filler.

So far as the madacam foundation is concerned, I judge the greatest difficulty to be encountered where the foundation is fairly solid, would be in the proper distribution of the material over the surface. If it be distributed by hand to a certain depth as concrete is distributed, and then rolled, we might expect a good foundation. In the usual method of dumping material from wagons, or by wheelbarrows in spots and then running over it with a roller, the high places get compressed and the low places are not touched, and as a result depressions may afterwards be found.

C. H. NICOLET: In connection with the use of macadam under concrete pavement, there is another important matter that comes up incidentally; namely, to distribute the material in such a way as to practically fill all the voids. At La Salle, some three or four years ago, there was considerable pavement laid with macadam foundation. Sometimes the material brought would be in large pieces run through a 2½ inch screen. The next load might be crusher run. I predicted at the time it was being laid that the work would be unsatisfactory and tried to influence the authorities to change their method, but I did not succeed. I told them my theory was that the fine stuff would drop down to fill the voids after a number of years, and leave a wavy pavement, and where the coarse stone was placed the sand bedding course would in time run down into the interstices and leave an uneven pavement. I had no official connection with this work, my interest was only that of a citizen. The prediction has proved true. In using macadam it is extremely important to see that the voids below are well filled.

PROF. BAKER: I am of the opinion that macadam foundations can be laid best by the use of the steam roller. I think we get better pavement where the steam roller is used.

MR. J. F. PARR: In East St. Louis, during the flood, the high water seeped in over the laterals and main sewer in the overflowed district, and caused a very great settlement because of the filling not having been properly tamped or flushed. The settlement was so great as to remove the support of the pavement and the heavy traffic crushed the concrete foundation of the pavement over these laterals. This has caused some opposition to the concrete foundations. Another cause of opposition is where we have to tear up so much to lay gas and other pipes. The concrete is seldom replaced properly and the result is that depressions occur.

H. G. PADDOCK: Prof. Baker's remark about the use of the steam roller is sustained by our experience at Moline. For our first brick pavement we used a 7-ton horse roller over the whole sub-grade before the macadam was put on. In time depressions were to be seen over old trenches. Since then we have used a 15-ton steam roller, and we have never had any depressions over trenches since.

PROF. BAKER: The last speaker has misapprehended my remark about the steam roller. I do not think it is of so much importance to have a heavy steam roller, as it is to have a roller which can be run transversely as well as longitudinally with the street. I think that has more to do with it than the weight of the roller. The disadvantage in the use of the horse roller on a broken stone road is that the feet of the horses break up the macadam, while with the steam roller the macadam is not thus disturbed. The steam roller is better to use on the sub-grade because it can be run transversely and longitudinally.

MR. PADDOCK: If you have a horse roller of sufficient weight you have too many horses to handle conveniently. I think very likely a 10-ton steam roller would be sufficient to accomplish the desired result.

THE CITY PARK OF A MEDIUM SIZED TOWN.

MR. O. F. DUBUIS: (MEMBER).

The construction of a city park is a specific problem for each town. The pattern or design carried out successfully to meet the wants of one city cannot be duplicated to meet those of another city of the same class. The grounds are different and the personality or individuality of cities is never repeated; characteristics found in one city's parks cannot be duplicated successfully in the design of another; the roads, structures, etc., are similar in their mechanical construction, but their contours, design and relation to each other will be different. Their particular locations in the park plan are arrived at only after consideration of numerous requirements.

The general outlines and make-up of a park project that might be common to more than one city would be as follows: Suppose the site is a 40-acre tract of ground, devoid of any natural beauty, rectangular in shape, located on the outskirts of an inland town having a population of 10,000 or more inhabitants. The first question that would arise would be the location of the park gates or entrances. These would be defined by proximity of car lines and public streets. At about the center of the park should be the pavilion or park house, facing the located park entrances. From this pavilion describe a tentative semi-circle of radius equal to two-thirds the distance to the nearest boundary fence facing the pavilion, about 440 feet. This is to be the skeleton contour shore line of a park lake of about seven acres of surface. The two ends of this semi-circumference would be closed together at the pavilion by natural graceful curves, and the regularity of this outline broken by depressions for small bays. One end of this lake area can be made picturesque by one or more islands connected by foot bridges.

The grounds in the rear of the pavilion could be divided into two squares of 10 acres each, more or less; one of these to be used for open lawn and playgrounds, and the other for grove and close planting. These parts would be connected, and in some cases encircled, by foot walks and drives of natural contours, running from the park gates and merging at the pavilion. Plant native trees and shrubs on the belt between drives and fences, closest to the fences, and scattered towards the inside, where single specimen of choicer stock can be used. The excavations from the lake surface should be figured for a depth of water of from 4 to 5 ft., and used for filling at the shore lines, and also in rounding up the small promontories and such other changes of ground elevations as will appear natural and necessary for quick drainage of storm-water. This arrangement of parts will give diversified landscape scenes, large enough in their scope, and giving to park visitors an easy comprehensive grasp of the opportunities of the grounds. These parts will need skillful blending with plantations and toning with floral display of hardy and other plants. The pavilion building, designed to have large covered balconies for shelter, must be made accessible for vehicles and foot people, and also have a boat landing from the lake. The basement would have well-appointed lavatories, and a storage room for park implements and fuel. Near the pavilion would be the band house, around which crowds of carriages and people can stop and circulate with safety. There should be stationary and movable settees provided for 1,000 visitors, and many more can find comfortable sitting places on the close mowed shady lawns. A place should also be provided for hitching horses, and suitable water hydrants made convenient of access and not hard to find.

The park swings, settees, arbors and other park equipment will after awhile become stationary fixtures in their most appropriate places. The contour of the lake should have clean gravel beaches in some of its shallow edges; some of the small promontories may be thickly planted, others more distinctly marked by granite boulders, the variety of striking colors contrasting sharply with the green of the lawn and the reflections of the water. The coves and small bays may be dotted with water plants. The small foot bridges should be neat and substantially built; no rustic woodwork being used in their construction, as it is too short lived and when decay has set in it cannot be repaired. The lake may be stocked with common and fancy varieties of gold and silver fish, excluding all game fish. The small stock of these inexpensive and hardy water beauties increases rapidly, and their frolics are much enjoyed by park visitors. Until ice is formed on the lake surface, some 25 or 30 water fowl may also make friends with the park visitors. After the ice has become of safe thickness the surface is the pleasure ground for skaters.

The principal park entrance is the terminus of a parkway or boulevard to the city. There are double driveways 30 ft. in width, bordered on the outside by evenly spaced, symmetrical trees. On the center lawn, between the roads, are massed beds of flowers in geometrical patterns; and at some future time one or more groups of monumental statuary or a fountain may give an artistic finish to this gateway of the city park. Along similar lines the boulevard is improved, adding 15-ft. side lawns and 8-ft. sidewalks to the drives; that is, if the parkway is not over six or seven blocks long. Beyond this length, one central driveway 50 ft. wide, and lawns 17 ft. each, with the 8-ft. sidewalks, are preferable and in better proportion to the length. The profile of the roadways and their construction are determined by the kind of material of which they are to be built. The grade from the curb to the lot line is the one usually adopted, 1 in. in 3 ft. The grade of the sidewalk for the parkway, as well as the one of the public street, should follow the curb grade. We all know the ugly appearance of a sidewalk 6 ft. wide (or any other width) perched on the lot grade with a 6 ft. or 8 ft. grass plat, and sometimes less, sloping down 3 or 4 ft. to the curb, and then a roadway 38 or 40 ft. wide. A street width should be half roadway, and the other half sidewalk and lawns. All other arrangements are noticeable for their disproportion.

On these general lines a city park is built. It is not pretentious, considering the beginning. It is not over costly, as park statistics show that omitting the cost of the land such park improvements will cost on an average of from $400 to $500 per acre, and can be maintained yearly for $100 per acre. We must consider the fact that for six months of each year it is the only summer outing ground of the city's dwellers and their visiting friends. No music hall, public library, or any other place of public entertainment can give all classes of people the same satisfaction that they derive from a visit to the well appointed city park.

REPORT OF THE COMMITTEE ON ARCHITECTURE.

The building business has been unusually good throughout the entire State, and most architects have been professionally employed, few buildings of any importance being built now except from the designs and under the supervision of an architect. The effect of good crops has been to make money abundant in the farming districts, so that an unusual number of good buildings have been erected in the villages and smaller towns. A considerable number of very large and costly fireproof structures have been completed or are in process of construction in Chicago; these include the Marshall Field store, the Tribune building, the Schlessinger & Mayer store, the Railway Exchange building, and the First National Bank building. This last replaces a structure built several years after the fire and apparently too good to be destroyed.

Some interesting changes in methods of construction have been noticed. The United States building was built on pile foundations, but these are exceptional in Chicago. Large concrete piers are now used for supporting most of the finest new office and store buildings. Excavations 6 to 8 ft. diameter are made where required, the earth being kept out by plank lining, supported by rings of wood or steel. These are extended down from 60 to 80 ft., either to the solid rock or to the hard sand just above it. The excavation is usually enlarged to 10 or 12 ft. diameter at the bottom, in order to provide the spread of the footings. Then the excavation is filled with concrete of cement and crushed stone tamped into place. Cap plates on the tops of these concrete piers receive steel girders on which are set the lines of columns of the structure.

A very remarkable instance of the use of these concrete foundation piers occurred during the rebuilding of the corner portion of Schlessinger & Mayer's store in Chicago about one year ago. To save time, these piers were put in while the building was still in use. Where the old foundations were in the way of the new ones, the basement columns were gripped between steel beams resting on temporary footings, when the old foundation was safely removed. Small elevator towers were placed on the sidewalk to remove dirt and admit materials, causing no obstruction in the street. After the Christmas trade was over, the building was closed, quickly removed, and the new building was opened for use in a few months.

This concrete foundation is free from the objection usually made to the steel and concrete foundation previously used, which rested on the soft clay and might settle unequally and continually. Neither is it affected by water or electric currents, as might be the case with steel embedded in concrete. There may be serious danger from electrolysis in some earlier buildings with steel footings, unless very carefully wired.

A new type of building for department stores is noticeable, which is an application of the simpler form of office building to this purpose. The Marshall Field new store is a good type. The walls are there reduced to the fireproof tiles and the external casing necessary to protect the steel columns and spandrel beams, leaving the entire space between them to be filled by very large windows, which abundantly light the interior of the store. The contrast of this simple and pleasing building with the elaborately decorated stone stores with much smaller windows, built 30 years since, is very great, and a comparison shows clearly the great superiority of the modern system of construction and design. The owners of most of the older type of stores have found it necessary to replace the two lower stories of the old structure by fronts chiefly composed of steel and plate glass, in order to admit the necessary light.

The work of the State Board of Examiners of Architects has been carried on as usual by monthly meetings, and two class examinations have been held, with others made during the regular sessions of the Board. About 800 applications for license were originally received from men claiming to have been in practice at the time the license law went into effect. A liberal policy was adopted in dealing with these applications, and 700 licenses were granted, although many of these persons were not fully qualified to safely practice the profession of architect, but might be competent builders or superintendents of construction.

There are 546 such licenses now in force, 154 having lapsed by death, removal from the State, retirement from the profession, or having been revoked for non-payment of the annual renewal fee prescribed by the law. According to this rate, in 20 years this entire class of architects will have disappeared and have been replaced by men who have proved their professional competency by successfully passing the prescribed examinations.

In addition thereto, 137 licenses granted after examination of applicants are now in effect, or 20% of the entire number, making a total of 683 licenses valid at this time. This is nearly the same number as at the end of the first year under the license law, showing that there is an ample number of architects to perform all the professional work required. Their location has changed considerably, for they are not so much concentrated in Chicago as at first, but are well distributed over the State, architects being located in every city of any importance. This favors the improvement of current architecture, and local architects now get most of the work, only the largest buildings being the work of architects located in Chicago or other large cities. The license law has had a marked effect in raising the standard of professional attainments, and it has benefited the public by fixing the responsibility for unsafe construction.

The members of this Society will doubtless visit the International Exhibition at St. Louis next summer, thus having a good opportunity to compare the exhibition buildings with those of the famous "White City" at Chicago in 1893.

Your committee feels the need of briefly mentioning the recent disaster at the Iroquois Theater, but prefers not to discuss the causes. But some facts appear prominently, and they deserve serious thought:

1. That Americans are disposed to pay too little attention to the safety of other persons.

2. That public officials too frequently perform their duties in a careless and perfunctory way.

3. That had existing laws and ordinances been properly enforced, such accidents could not occur.

4. After the public has recovered from the shock, it appears probable that necessary precautions for the safety of the public will be neglected pretty much as before. Respectfully submitted,

N. C. RICKER, Chairman.
S. A. BULLARD,
F. OSWALD,
Committee.

REPORT OF THE COMMITTEE ON STRUCTURAL ENGINEERING.

The past year has been one of unusual activity in structural lines. Contrary to expectations, the unprecedented demand for steel of the preceding years was continued practically without change. The continued betterments on railways called for a large amount of railway bridge work. The demand for highway bridges, ordinarily quite a constant quantity, was increased by unprecedented floods in the Mississippi Valley and other localities. The construction of fireproof buildings has kept pace with construction in other lines.

The use of concrete-steel construction for bridges and buildings has shown a decided increase over preceding years. The Patent Office records show a number of new systems of reinforced concrete construction, and the end is probably not yet. The calculation of stresses in reinforced concrete structures is accomplished for the most part by means of empirical formulas with constants based on limited data. Many of these structures have been badly designed and others carelessly constructed, so that many of them will doubtless be very short-lived.

Concrete has come to be quite largely used for building walls of office buildings and shops. Where the height is great in proportion to the thickness some method of reinforcement is used. For shops the most approved construction is to build concrete or brick walls between the columns up to the bottom of the windows, while the space between the windows and the sheathing of the roof is constructed of reinforced concrete.

A new fireproof roofing material for shops is Ferroinclave. "It is made by coating a special crimped or corrugated iron or steel on both sides with a mixture of Portland cement and sand, after which it is painted on the upper side. The sheets are made of No. 22 or No. 24 sheet steel, and full sized sheets are 20 ins. wide and 10 ft. long. The steel is crimped or corrugated with corrugations about 2 ins. wide and ½ in. deep, the width of the corrugation on the outer side being less than on the inner side, thus forming a key to hold the cement mortar in place. The sheets are laid in the same manner as corrugated steel, and a mortar coating composed of 1 part Portland cement and 2 parts sand is plastered on the upper and lower surfaces to a thickness of ⅜-in. above and below the corrugations, making the total thickness of the roofing 1¼ ins. The weight is about 15 lbs. per square foot and the cost is about $21 per square, complete in place."*

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*From "Steel Mill Buildings," by Milo S. Ketchum.—Engineering News Pub. Co.

The tendency of modern practice in bridge design is toward structures that give a maximum rigidity even at the expense of material. In railway bridges, the webs of plate girders are being made thicker, ⅜-in. being a minimum, and such bridges are only used for short spans. For spans of say 100 to 200 ft., riveted trusses are preferred, while above 200 ft. pin-connected trusses are still used. Very little progress is being made in highway bridge design, although there is a tendency toward the use of riveted bridges for spans up to say 150 ft. Much has been said on the inferiority of highway bridge designs, but little can be done until the public which pays for the bridges is educated to understand or is forced by law to see, that highway bridges should be designed by competent engineers. Many highway and railway bridges are being built of reinforced concrete. If properly designed and constructed these structures are very permanent and satisfactory. However, on account of defective designs and poor workmanship many of the reinforced concrete bridges recently put in will doubtless prove short-lived.

In steel buildings, the Z-bar column seems to be losing ground and is being replaced by the column composed of four angles and a plate. The cost of fabricating the latter is less than for the Z-bar column; the material can be obtained more easily, and connections are made with equal ease. On account of the peculiar section, Z-bars are expensive to roll, and in all probability this section will soon be no longer rolled.

The sand blast is coming into quite general use for cleaning structural steel. In connection with the protection of steel from corrosion the recent experiments on protection of steel by concrete, made by Prof. Norton at the Insurance Engineering Experiment Station, Boston, Mass., are of interest. These experiments show conclusively that the corrosion of steel is prevented, whether dry or submerged, by enclosing it on all sides with a coating of cement mortar about 1½ ins. in thickness. The samples used in these tests included pieces of steel in all stages of corrosion, from bright steel to steel with rust ⅛-in. deep; clean and covered with oil. Particular stress is laid on the importance of mixing the concrete very wet.

The most important addition to the facilities for fabricating steel work is the Ambridge plant of the American Bridge Co. This shop has been erected at a cost of about $5,000,000, and is the largest and most complete bridge shop in the world. The main shop for heavy bridge and riveted work has a capacity of 15,000 tons per month; the highway bridge shop has a capacity of 5,000 tons per month, and the eye-bar shop a capacity of 4,000 tons per month; making a total capacity of 24,000 tons per month. The eye-bar shop is notable for its size and for the size of the eye-bars which can be made, as bars 18 ins. deep and 3 ins. thick, having 40-in. heads, can be fabricated with ease. When the Ambridge plant goes into full operation it will doubtless mean the closing down of a number of separate plants of the American Bridge Co. The effect of this shop on shop costs of fabricating steel will be watched with interest. During the past few years many small shops have sprung up and in most cases have been paying investments. Many of these plants will doubtless be forced to shut down when the larger shops get short of work.

M. S. KETCHUM, Chairman.
L. K. SHERMAN,
H. A. STEVENS,
Committee.

REPORT OF THE COMMITTEE ON MECHANICAL ENGINEERING.

A general review of the mechanical world in the last twelve months that have elapsed since our last meeting throws the focus of our searchlight upon two objectives. The one comprises that which has already been achieved; the other an imaginary world, full of brilliant promise. It is to this latter field that the eyes of so many bright inventive minds are turned.

At the St. Louis Exhibition, which probably most of us will have occasion to visit during the year, will be found the highest types of efficiency and the best which the world has to show. There will be a 5000-H. P. reciprocating steam engine, directly harnessed to an electrical generator. In the same room will be found a rotary engine of nearly this capacity doing similar work. The rotary engine has been the dream of the inventor since the birth of steam, and yet it has only been possible to make an efficient rotary steam engine in the dawn of the 20th century. So keen is the rivalry between these mechanical giants that a difference in efficiency amounting to 10% is sufficient to be blazoned throughout the whole world as an event of the greatest importance. We have recently had a "new Richmond in the field," in the shape of a gas engine or internal combustion engine, and it is the general impression that the last one is a newcomer, in fact, quite the "boy of the family." As a matter of fact, he came into the world almost with the coming of gunpowder, and was altogether too obstreperous to be of much use until Dr. Otto succeeded in making a harness that was suitable to circumscribe his temper.

The construction of large gas engines throughout Europe has come to be a matter of fact. Gas engines of from 1000 to 3000-H. P. were first built to utilize the waste gases from blast furnaces, coke ovens, etc.; in other words, the fuel was a by-product. So extremely profitable have they proved that we see in America and throughout the world people putting up gas works for the sole purpose of generating gas to run these engines, both large and small, because of their great economy and efficiency. At this point we find an interesting parallel: the efficiency of a small gas engine is approximately the same as that of a large one, while the efficiency of a steam engine increases with the size of the unit. Thus we burn 8 or 10 lbs. of coal to produce one H. P.-hour with a small steam engine, and decrease this amount as we go up, to a possible 3 or 2 lbs., as used by the largest and most elaborate triple compound condensing engines. With the suction producer plant furnishing gas that will give one H. P.-hour on 1 lb. of coal, and that of low grade, we truly have a dramatic and sensational picture spread before us.

The first cost of a gas engine, with its corollary or producer plant attached, may be said to be about 25% more than the cost of the latest type of steam engine with its boiler attachment and other necessary appurtenances. This difference promises soon to be eliminated, but it is of little consequence what this difference is as long as the difference in coal consumption remains so greatly in favor of the internal combustion engine. Gas plants for making fuel for these engines have been in service for many years, but it is only recently that it has been profitable or possible to make them in small units. Before we meet in convention another twelve months hence, however, suction producer plants will be sold like hard coal stoves and will not require any more attention to operate, and this for small units of power ranging from 10-H. P. Truly the time seems near at hand when we may send to the corner grocery store to purchase a half a pint of horsepower.

In closing this review it is proper to say that the New York Central & Hudson River Ry. have recently let contracts for $18,000,000 worth of modern electrical power plants, to handle its entire train service electrically between Spuyten Duyvil and the 42nd street terminus.

We have been living for a century in an age of steam, and this because of our supposed inexhaustible coal fields. Already the professors are telling us how many years we can draw upon that bank account at the present wasteful rate. Truly, if we can make henceforth one pound of coal do the work of two pounds, we have begun the new century well.

J. C. QUADE, Chairman.
T. W. SNOW,
R. H. SLOCUM,
Committee.

REPORT OF THE COMMITTEE ON ROADS AND PAVEMENTS.

According to the message of Gov. Odell, of New York, that State is in a fair way under its laws on the subject, to get a fine system of highways within the near future. There are several other States that have already or are now considering practical laws solving the problem of good roads, and your committee believes that the great State of Illinois, through its Legislature, will soon enact laws that will put it among the good-road States. We have now in some localities short sections of good roads, but we will never have a general system of good roads until the State contributes a large percentage of the cost, and regulates the construction.

Under the present laws there is no system, each small district being perfectly independent, and we are enabled to legally go on from year to year using the people's money with (in many districts) little or no benefit to the road, the multiplicity of executive bodies under our present laws making it impossible to have any specific plans for road making. But should the State pay any considerable portion of the cost of making the road, proper plans and specifications could be insisted on by the State as a condition of the aid being given.

With a proper State Engineering Department, which would be necessary under such laws, plans and specifications would be made and such material used as seemed most economical for the locality in which the work was to be done, and as such work would have to be done by contract, competition would force the use of the best modern machinery for doing the work.

The matter of pavements, after going through the experimental stage, has been worked out so that any municipality can, if it likes, select one of the several tried pavements and be reasonably sure of getting good results. In streets that have street railway tracks with wooden ties, there are still some failures, owing to the fact that a proper foundation is not made under the tie, and as the tie supports a portion of the pavement, the pavement will fail unless it is held in place.

H. G. PADDOCK, Chairman.
I. O. BAKER,
W. H. TARRANT,
Committee.

THE ILLINOIS GOOD ROADS COMMISSION.

BY DE WITT W. SMITH.

(Chairman of the Illinois State Good Roads Commission.)

Your secretary has asked me to give you some information as to "the organization and purposes of the Illinois Good Roads Commission, together with an account of the work so far done, with an outline of the proposed plan of action on behalf of good roads for Illinois." The following extract from the legislative act under which the commission was appointed, defines its duties, and in itself answers to a great extent the question:

> "It shall be the duty of this Commission to investigate the various problems of road building in Illinois, such as the best and most economical native materials, the best system of road drainage, the best and most practicable methods by which the burden of cost may be equitably distributed among all the people, such as Federal, State and County aid, convict labor, etc., etc. The results of the investigations and studies of the Commission shall be embodied in a report to the next General Assembly, to be accompanied by the form of a bill for an act to amend the present road laws of the state so as to conform to the present advanced thought and requirements on the subject of road building. The sum of $5,000, or such part thereof as is necessary, is hereby appropriated out of the State Treasury, for the expenses of the said Commission."

The Commission was organized last October, and may be said to have scarcely as yet entered upon its real work. Our first step was to put ourselves in communication with the U. S. Bureau of Roads Enquiry, and with various State Commissioners, notably those of Massachusetts, New York and New Jersey, in which States we understand the greatest progress has been made in the systematic study and practice of the art of road building. Our next step was in an effort to secure as nearly as possible, with the limited means at our disposal, a survey of the present extent and condition of the wagon roads of the State. To accomplish this we have addressed a circular letter to the various boards of highway and county commissioners, asking them to give us answers to the following inquiries:

1. How many miles of wagon road in your township, exclusive of streets in cities, towns and villages?
2. How many miles of improved road surfaced with hard material, exclusive of streets as above?
3. Kinds of material used in surfacing improved roads as above, with cost of same per mile?
4. What native material is there in your township that might be used for surfacing roads, such as stone of various kinds, gravel, etc., with cost of same per sq. yd. placed on the road?

5. How many miles of tiled ditches for road drainage in your township?

6. Do you regard the use of tile drainage on roads as of material benefit?

7. What is the total amount of taxes collected in your township for road and bridge purposes, including poll tax at its cash value?

8. About what proportion of above taxes are used for road purposes, exclusive of bridges?

9. What amount of money do you receive from your county for road and bridge purposes?

10. What proportion of county aid is for road improvement, exclusive of bridges?

11. What is the cost of road administration in your township, such as pay of Commissioners of Highways and Road Overseers?

12. How many road overseers in your township exclusive of Commissioners of Highways?

13. What mechanical appliances are used in your township for road making and repairs, with total cost of such appliances?

14. What is the general character of the soil in your township, black loam, clay, sand, etc.? If variable, about what is the proportion of each class of soil?

15. What is the general character of the surface—level or hilly?

16. Have any hard roads been built in your township under the provisions of the present "Hard Roads" law of the State, and if so do you find that said law is satisfactory in its practical workings?

The replies are now being received, and are generally of a satisfactory character. It is not to be expected that the survey thus obtained will be exhaustive, nor in every way satisfactory, but it will put us in possession of a mass of information which, properly tabulated, will be of great value.

While we may not accomplish much that is startling or brilliant, we may at least do some good foundation work. The people have a right to know what their servants are doing, and it will be a pleasure to us to keep the Illinois Society of Engineers and Surveyors informed from time to time of the progress of our work. May we not bespeak your active co-operation, advice and support? Surely no class of men are better qualified, nor should be better disposed to help us.

If our work is such as to commend itself to the good sense of the next General Assembly to which we are to report, it must prove itself to be practical and expedient, and it must carry with it at least the appearance of wisdom. But however wise, practical and expedient it may possibly be, it might still lack the one vital requisite, that it shall receive the approval of popular sentiment. This popular sentiment, clearly and forcibly expressed, is the one argument before which the wise legislator bows.

With the scarcity of natural material for road building, with the high price of artificial material (such as brick, etc.), with the soft, mucky character of much of our soil, and above all the conservative temper of the farmers of the State, and their natural reluctance to rush blind-fold into untrodden and expensive paths of experiment, it behooves us to move slowly and cautiously towards the achievements of a permanent system of improved roads. But with all the difficulties of the situation, the law of compensation still holds good. Throughout the greater portion of Illinois the general surface of the country is level, and expensive grading is not required, our streams are comparatively few and sluggish in their flow, we do not need many expensive bridges, and we have generally an ideal soil for the great essential of under-drainage.

All authorities agree upon the subject of drainage being a prime requisite. The replies received from highway commissioners throughout Illinois indicate an almost universal approval of a system of tile drainage along our roads, the only exceptions noted having come from sections of country where there is a stiff clay soil almost impervious to water. It therefore happens, fortunately for us, that the very best preparatory step we can take in the direction of hard roads will give us also the very best dirt roads. This step is to provide a thoroughly under-drained surface. We have all seen tile drains laid along public roads that were entirely inadequate to the drainage thereof, and yet they were expected to drain not only the road itself, but also the adjoining fields of the influential citizens alongside of whose farms they usually run. And because the overworked tile drain could not in the nature of things accomplish the unreasonable task imposed upon it, the wayfaring man, passing that way, is liable to conclude that the under-drainage of roads is a failure. But the fault is in the abuse of the system and not its use.

There is a growing sentiment in favor of the idea that the county and state, and the general government as well, should bear a proportion of the expense of construction of hard roads, for the reason that the entire public, and especially the cities, are benefited by them.

Good wagon roads may seem to be rivals of railways and interurban lines, and in a small measure they may be so in the vicinity of cities, but in a far greater measure they are a direct benefit. Good wagon roads running towards a railway serve as feeders to it and those running parallel to it contribute to the prosperity of the communities, and help build up the towns and villages along the line. They also serve to equalize the inflow of farm products for shipment, and prevent those gluts (which so often occur when wagon roads are good), and the long lines of empty cars standing on the sidetracks when the wagon roads are bad. This view is generally accepted by the railway men of the country, and many of the most earnest advocates of the good roads movement are to be found amongst them.

We have a condition of affairs here to-day that needs revolutionizing; a condition that is working a blight upon the country and that must for the country's good be checked in some way. I allude to the movement, from the farms to the cities and towns, of the bright and ambitious young men and women, and of the rich and prosperous old men and their families. This is brought about almost entirely from the lack of social life among farmers and from the lack of educational advantages. We have winters in Illinois when farmers' families are literally mud-bound for months at a time, utterly isolated from their neighbors and from the country towns. Is it any wonder that they hate the farm and farm-life, and that they throng to the cities where they may enjoy the companionship of their kind? Build good roads throughout the country districts and you will see a change. The movement will be reversed.

It is hardly too much to say that the salvation of our nation, in a political sense, rests upon the preservation of the old-fashioned country life. We may poke fun at the farmer, say that he is narrow and hide-bound, that he lacks breadth of view and depth of insight, and all that. But take him all in all, he is a safer and better thinker than his brother in town. Let us help him fix his roads, and make things pleasant for him on the farm, and most of the money the cities may spend on the country roads will come back to them in the way of better and more evenly regulated trade with the farmer.

NOTE.—At a later meeting the following resolution was adopted:

Resolved, That the Illinois Society of Engineers and Surveyors desires to express its appreciation of the work of the Good Roads Commission of Illinois, and to express its sympathy and interest in the movement. It also offers its co-operation, and desires to express the hope that the movement will prove of lasting benefit to the road interests of the State.

ILLINOIS ENGINEERS AND ILLINOIS ROADS.

BY IRA O. BAKER (MEMBER).

Engineers frequently complain that in emoluments and in public esteem the engineering profession does not stand as high as it deserves, either in comparison with other professions or in view of the importance of the interest involved. There is doubtless some justification for this contention, and the reason for this lack of appreciation of engineers by the public is not far to seek. The work of the engineer is almost wholly with inanimate things, the world of dead matter and of force. The engineer devotes all, or nearly all, of his time to the materials, the laws and the forces of nature, and scarcely any time or thought to the life of the world, to its commercial, political, intellectual, and social activities.

Natural law, dead matter and lifeless force make up his working world; and in these alone many engineers live and move and have their professional being, and they have hardly any conception of any other world. The social and the political problems of the community in which they live seem not to concern them. They do their work largely apart and separate from other men, and particularly from those men who are making and molding public opinion and who are giving time and thought to the social and political problems of the community. These engineers give themselves so much to the contemplation of the material problems of their profession that they lose interest in the intellectual and social life of the world, and lack appreciation and enjoyment of literature and art; and consequently have but little in common with the men and women whom they meet. The minds of such are all shop, out of which only shop talk can be drawn. Such men are little more than animal tools, and are liable to be something of a bore to their friends and a weariness to the flesh of the more liberal-minded men of the other professions. Their influence upon the social and the intellectual life of the community is zero; and it is no wonder that those who mold and make public opinion do not accord these engineers a high place in their estimation. Nor need it be a surprise that the returns for professional labors are too much like those received by other ciphers in society, and too little like that obtained by those who make and mold public opinion.

There is another reason that has prevented the engineering profession from receiving from the public the recognition justly due. The engineer who is competent and sees where the public could be benefited by his professional knowledge is often reluctant to offer advice, either because he thinks he should be paid for his services or because he fears he will be accused of seeking professional employment. This ought not to be. If an epidemic threatens a community, physicians are not averse to serving gratuitously upon a health committee. If a new charter is to be obtained for the city, lawyers are easily found who are ready to contribute their professional knowledge for the benefit of the public. The engineer also should be ready to do his share in serving the public.

In this State there is just now a distinct call to the engineers of the State to help in finding the best solution of the good-road problem. The Legislature at its last session authorized the Governor to appoint a commission to study the road question and report its conclusions to the next Legislature. The commission has been appointed, and its report is sure to bring the road question up for active consideration. Is it too much to say that the civil engineers of the State, particularly the members of this Society, scattered in the several communities, should contribute of their knowledge to the solution of this problem? In one phase the road question has to do with the materials and the forces of nature, and hence is in the field of the engineer's professional activity. In another phase, the road question is quantitative rather than qualitative, and since the engineer in his professional work is accustomed to deal wholly with quantitative questions, he should be peculiarly fitted to help solve the road problem. He is especially qualified by his professional training to consider questions as to the amount of the present traffic and its cost, the possible future traffic and its probable cost, the cost of maintenance of the present and of the proposed road, the materials for the road surface, and the details of the methods of construction.

But the good-road problem is usually much more than a question of materials and the methods of using them. Matters relating to efficient road administration, and to the equitable adjustment of the expense of any proposed improvement between the lowest and the various higher governmental units, and a proper distribution of the expense between the present and the future, will require the wisest statesmanship, the most carful consideration of conflicting interests, and a recognition of the power of established practice. The engineer who has been trained to weigh causes and foresee results should be able to throw some light upon this part of the good-road problem.

The economics of the good-road problem is not a mere academic question, but one vibrant with interest to the whole State. If you believe, with some, that the people are losing vast sums through poor wagon roads, then you should lend a hand to stop this waste. If you believe, with others, that any attempt to spend considerable sums in road improvement would be a public calamity, then you should do all in your power to prevent any such useless expenditure. This question has been before the public for about a decade, but it is a curious fact that the contentions of one side have never been seriously considered by the other. The disputants have faced in opposite directions, and each has addressed only those who held his own views, and consequently little or no progress has been made toward the solution of the problem. But this condition of affairs is likely to come to an end, for the report of the Illinois Good-Roads Commission will bring the matter up in the next Legislature, and an attempt will probably be made to embody some view of road reform in legal enactment. Within a year the discussion of the good-road question is likely to take on a new aspect in this State, and engineers should be ready to discuss the question with intelligence. The discussion should proceed with more light and less heat than has been common in the past.

It is frequently claimed by engineers that the wagon roads would be better and more economically cared for, if they were under the direction of engineers. How many of our number have shown to the public any interest in good roads? How many Illinois engineers have, by a public discussion of the good-road problem, given to the public any evidence of a careful study of that problem? I am not unmindful that at the annual meetings of our Society there have been papers and reports upon various road matters; but such articles are written for engineers, while nearly all the rural roads are in name and in fact under the control of the farmers—or, to be more specific, under the actual control of the landowners—and it is highly improbable that any material legal change will be made in road matters which is not approved by the farmers. The problem, then, is to induce the farmers to take better care of the present roads, or to instruct them in improved methods of caring for the present roads, or to persuade them to approve means that will lead to better roads than the present ones can ever be.

As showing the attitude of a rural community toward the question of road improvement, the following recent experience may be of some interest: I was asked at short notice to address a county farmer's institute, and the secretary (without consulting me) announced the subject as "Good Roads and How to Secure Them." When I found a large hall packed to the doors, and also found that I was a stranger to the entire audience, I said that I was glad to appear before them to discuss the good-road problem, and was explaining that there had been less improvement in the past few years in wagon roads than in most other rural matters, when a man in the middle of the hall shouted: "Mister, are you selling bicycles or automobiles?" While there was no open applause, a distinct undertone of approval greeted this remark, which was significant, in view of the undemonstrative character of such audiences. As soon as I could catch my breath and get my bearings, I said: "I have neither bicycles nor automobiles to sell. I have no axe to grind. I came only to discuss what can be done to improve the ordinary earth road." Tumultuous applause greeted this remark.

I then read my paper, and it was followed by an animated discussion, which was prolonged all afternoon, even into the dusk of the evening, to the exclusion of the other business of the session and against the efforts of the officers. The discussion seemed to show that a large proportion of the farmers were anxious to learn methods of improving ordinary earth road, and that a considerable number of them have observed the roads and reflected to good purpose on what they saw. After the meeting the man who had interrupted made an apology, and said that he had once attended a good-road convention in a distant city and "supposed that all traveling good-road speakers talked alike." From numerous public and private remarks it also appears that there were a good many who were surprised to learn that anything could be done to improve the ordinary earth road.

Let us turn now to an entirely different feature of the good road problem. Whether or not the Illinois Good-Road Commission makes a report, and whether or not that report stimulates debate either inside or outside of legislative halls, there still remain several minor road problems for which the public must have a solution, and which engineers, better than any other class, are fitted to solve. One of the minor problems is to find a suitable material for the floors of highway bridges. At present in this State oak planks are generally, if not always used; but it is now nearly impossible to find fairly satisfactory lumber for this purpose, and in the future the difficulty will increase. Not only is lumber growing poorer in quality and more scarce, but its cost is increasing rapidly. Apparently, concrete is the most promising substitute for lumber for bridge floors, but we lack data for its intelligent use. In the first place, little or nothing is known about the shearing strength of concrete, and but little is known about its tensile strength. Of course, these data must be obtained by those having access to a testing machine. The University of Illinois has made a start toward the determination of what may be called the co-efficients of concrete. The University has also begun some experiments directly upon the strength of concrete when employed for floors of highway bridges. In the second place, almost nothing is known about the probable effect of traffic in disintegrating the top surface of a concrete bridge floor. The writer has done something to solve this phase of this question. A few years ago the writer constructed a concrete bridge floor in the grounds of the University of Illinois to determine the abrasive effect of traffic, but the traffic was light and a year or two after the bridge floor was completed the roadway was paved and hence no valuable results were obtained. Later the writer attempted to get a city to try a concrete floor on a bridge in process of construction, but the aldermen thought the finances of the municipality did not warrant the experiment. He has, however, persuaded some highway commissioners to construct such a bridge floor, but cold weather has prevented the laying of the concrete. It is desirable that the problem should be attacked in several different localities and by different experimenters.

Another of the relatively minor problems that the public needs help upon is this: Can a broken stone road be built in the corn belt of Illinois that will not be pulled to pieces by the mud brought upon it from the unpaved roadside? Some poorly constructed roads have been quickly pulled to pieces, which seems to show that there is at best only a narrow margin between success and failure. As the result of a single piece of road would not be conclusive, it is desirable that also this experiment should be made in different localities by different observers, the methods and results in each case being carefully recorded and published.

Before closing there is another matter, which, although really small in itself, is worthy of mention, if for no other reason than to show that the engineers of Illinois did not have a very marked influence upon legislative action in matters relating to a purely engineering subject. A statute of the State of Illinois prescribes a penalty if any one shall build a highway bridge which is not capable of carrying 100 pounds per square foot. It does not need to be pointed out to a body of engineers that the law does not specifiy whether or not the resulting stress may be nearly equal to the ultimate strength of the material, or be equal to the elastic limit, or be no more than half of the elastic limit. Apparently the man who drew this law did not know that a traction engine weighing a good deal less than 100 pounds per square foot of the bridge floor might strain the bridge much more than that uniform load. Of course, the law is absurd in that it makes no distinction between the assumed unit load on a panel and that on the whole span, and makes no distinction between long and short span bridges, nor between a bridge in a remote rural district and one on a street of a large city. The writer has tried several times to find who was responsible for this surprising law, but can learn nothing whatsoever about its origin.

Perhaps this is a good place to bring this article to a close by repeating that, for the benefit of the public and their own professional standing, it is desirable for engineers to take a more prominent part in the making and molding of public opinion, and the question of good roads is a good place to begin.

THE PRESENT PRACTICE IN STONE ROAD CONSTRUCTION IN NORTHERN ILLINOIS.

BY LESLIE A. WATERBURY: (MEMBER).

The writer's observation of road construction has been limited to the districts about Dixon and Polo. Even these two places, although but a few miles apart, use methods which are quite different. Palmyra township, in which Dixon is located, has built all of its roads by contract, while Buffalo township, in which Polo is situated, has built but one piece of road in that way and does not favor the contract system. Buffalo township places some of its macadam in trenches, while Palmyra township uses no trench construction. In other details there are marked differences of construction in these two districts.

Palmyra township, which is in Lee county, is crossed by Rock River and is quite hilly, especially near the river. The soil in this vicinity has some sand in its composition, which makes it a good foundaton for macadam. Buffalo township is located in Ogle county. Its surface is rolling prairie and its soil is black loam, upon which it is more difficult to construct good roads than upon the soil of the other township.

Limestone is abundant in both localities, but there are not as many outcroppings in Buffalo township as in Palmyra. Stone from different quarries varies a little, and stone from different parts of the same quarry is not entirely uniform. The stone taken from the upper layers of a quarry is usually softer than that from lower layers, but after being exposed to the air for some time, it becomes harder. Neither township has given any attention to under-drainage.

To prepare the road for laying the stone, Palmyra township grades the surface so that there will be a little less crown than is desired for the finished road. Crushed stone, from which the very fine material has been removed by screening, is then laid, making the depth of stone 10 ins. at the center and 6 ins. at the edges. To protect the edges of the roadway, a furrow is plowed on each side and the dirt is banked against the stone with a grader. To finish the road, fine screenings are placed on the surface and the road is rolled. The usual width of roadway is 20 ft. The cost of the finished road is about $5 per lin. rod, or $1,600 per mile. Quarries are opened along the road so that the average haul is probably about one mile.

It has been observed in Palmyra township that on some of the steeper hills the stone is dislocated from the surface, particularly at the edges of the road, by wagons which are not supplied with brakes.

A driver, in descending a hill with a loaded wagon, will make it easier for the horses by turning out so as to cause the wagon to run or slide diagonally. If the surface of the road is not firm this action will displace the loose stones. This trouble could perhaps be remedied, partially at least, by placing the stone in a trench to give more support to the edges, and by rolling the surface more to make it as compact as possible.

Aside from the point mentioned, the roads of Palmyra township are about as economically constructed as possible. The soil is sandy enough and the surface has slope enough to prevent any trouble from lack of under-drainage, and therefore it would not pay to employ tile drains. The use of stone screened into two sizes, so that the fine material is removed, is advantageous, since the variety of sizes of the pieces of stone will make a more compact mass than if composed of uniform pieces. If the stone were rolled more when being laid, the variety of sizes would not be of so much benefit, since it would tend to prevent the pieces from being wedged together. As it is, the rolling is done when the road is finished and is probably of but little value in compacting the mass. However, the rolling is not wasted, for it will leave the surface in shape to attract travel, whereas otherwise the stone road would not be used until the dirt track was impassable, at which time the surface of the stone would be picked up by muddy wheels.

In Buffalo township, stone which is laid on hilly ground is usually placed in a trench to prevent the edges from washing away. On level ground, the stone is placed on the surface of the soil. The first layer consists of coarse stone, broken in place by hand. This layer is made at least 8 ins. thick where the road has good drainage, and from 10 to 12 ins. thick where the road is particularly bad at wet seasons of the year. This layer is then rolled with a 6-ton horse roller. On top of the first layer is placed 3 ins. of coarse crushed stone. This layer is also rolled. A layer 2 ins. thick of finer crushed stone is then placed on the road and on this some fine screenings. The road is then rolled again. The width of roadway built during the past year is 12 ft. on high ground and 20 ft. in creek bottoms.

The construction which is used in Buffalo township does not seem to be the most economical that could be designed. It should not be necessary to use 14 ins. of stone to distribute the load of a wagon wheel so that the soil beneath would resist the pressure. If the soil is too soft to support the stone at wet seasons of the year, the remedy should be the removal of the water instead of an increase in the depth of stone. One of the reasons for using the depth of stone mentioned is that the lower layer of stone will not be so compact but that it will act as a drain. This does not seem to be a very good nor economical plan, because the drainage should be deep enough to be below frost. If, in one portion of the road, the lower layer is more compact than the portion on higher ground, or if it is frozen, the water from the higher ground will follow the lower layer of stone until it comes to the frozen or clogged portion, where it will be backed up, perhaps forming a spring.

This is especially likely to occur if the trench construction is used and if the soil is composed of clay. Some such action did occur at one place in Buffalo township and may have been due to the causes mentioned. In such cases tile drains ought to help considerably in remedying the defects. Another thing which might help to keep the foundation of the road dry is the use of a thin layer of stiff clay, well rolled, between two of the layers of stone. This layer of clay should extend beyond the edge of the trench in which the stone beneath it is placed, so as to carry water to a point outside of the trench. The layer or layers of stone above the clay could also be extended to the edge of the clay layer, and protection for the edges of this stone could be obtained by throwing up a little dirt against it with a grader, as is done in Palmyra township.

Of the stone road constructed in Buffalo township previous to 1903, one mile was built in 1896, one mile in 1897, one mile in 1898, two miles in 1900, and two miles in 1901. The cost, including grading, of the two miles built in 1900, was $1,700 per mile. Part was built by contract, the price, exclusive of the preparation of the subgrade, being $2,180 for 1½ miles, or $1,453.33 per mile. Of the work done by the township, $642 was donated. This included nearly the entire cost of grading. The stone was laid 10 ft. wide, 10 ins. deep at the center and 6 ins. at the edges. The average length of haul was 1½ miles, and the cost of hauling was 20 cts. per yd. or 13⅓ cts. per cu. yd. per mile, or about 10 cts. per ton per mile. The average cost of quarrying and crushing was 40 cts. per cu. yd. The cost of the two miles of road constructed in 1901 was $1,800 per mile. This road was built by the township by day labor. The width in this case was 9 ft. The depth of stone was 14 ins. at the center and 10 ins. at the edges. The average haul in this case was about 3 miles.

Woosung township, which lies between Buffalo and Palmyra townships, has five miles of macadam, which was built by Dixon contractors according to the method used in Palmyra township. The width is 12 ft. The depth of stone is 10 ins. at the center of the roadway and 6 ins. at the edges. The contract price for 1¼ miles built in 1899 was $4.20 per lin. rod, or $1,344 per mile. The price for 3¾ miles built in 1900 was $4.40 per lin. rod, or $1,408 per mile.

All of the places mentioned use care to exclude clay and quarry dirt from the stone, so that the fine top dressing is composed of clean stone. A little clay on the top of a stone road will make a good, smooth surface when dry, but when wet it is picked up by wheels, taking the finer stone with it.

I have already mentioned the fact that Palmyra township builds its roads by contract. The reason for this is that the township believes this method to be cheaper than to build the roads themselves. The reason Buffalo township builds its own roads is that a large part of the hauling is donated and it is difficult to use donated labor if the work is done by contract. The amount of donated labor which a certain part of the township will furnish is one of the items determining where the work for the year will be done. The road tax which has been levied in Buffalo township for the past few years is $1 on each $100 of valuation. This furnishes the entire appropriation for road and bridge purposes, including hard roads. The road tax levied in Woosung township, during the time stone roads were being built was $1 for hard roads and 60 cts. for general road and bridge purposes. Palmyra township levies but one tax for all road and bridge purposes, which I think is about 75 cts. on each $100 of valuation.

All of the roads mentioned have been satisfactory and are much appreciated by all who use them. The writer is indebted to Mr. Harry Tipper, Town Clerk of Buffalo township, and to Mr. G. J. Gitt, Street Commissioner of Dixon, for assistance in obtaining information.

ROAD CONSTRUCTION IN MASSACHUSETTS, NEW JERSEY AND CONNECTICUT.

BY L. G. PARKER: (MEMBER).

This paper has been written for the purpose of pointing out the methods of constructing roads in those States which are farthest advanced in road construction: Massachusetts, New Jersey and Connecticut. The various highway commissioners' reports have been the writer's source of information for this paper. It may be stated that Maryland, New York and Vermont have done considerable by way of improving their highways.

MASSACHUSETTS.

The State highways are under the control of the Massachusetts Highway Commission, which is composed of three members appointed by the Governor, one being appointed each year to serve for three years. It is the duty of this commission to apportion the State appropriation among the various counties, no county being permitted to construct more than 10 miles of road in any one year, without previous approval of the Governor and Council. The commission has made it a rule to make a county's percentage of the appropriation equal to the percentage that the total length of the roads in the county bears to the total length of the roads in the State; city and village streets are not included. The first appropriation under the State Aid Law was made in 1894. The several appropriations up to the present time are as follows: 1894, $300,000; 1895, $500,000; 1896, $600,000; 1897, $800,000; 1898, $400,000; 1899-1902, $500,000 per year; and in 1903, $2,250,000 for five years, at $450,000 per year.

A chief engineer is appointed by the commissioners, and is responsible for the engineering operations involved. He appoints assistant division and resident engineers. A county, town or city desiring the improvement of a highway may apply by petition through either the county commissioners, selectmen or mayor to the Commissioners, furnishing maps and profiles of the highway. If the Commission approves the petition it takes charge of the construction.

Contracts for the construction of highways are preferably let to the local cities or townships. The contract is let on the unit plan, i. e., excavation is paid for by the cubic yard, haulage by the ton, etc. The State pays for the entire cost in the first instance, but collects 25% from the county after the completion of the work. Roads constructed by State aid become State property, the State assuming the burden of keeping them in repair. The average cost of maintenance up to the present time has been $129.29 per mile per year. The average cost of maintenance per mile in 1903 was $128.34.

Gravel and broken stone have been used in the construction of the State aid roads, but mainly the latter. Most of these stone roads are of macadam construction, the Commission not having been well satisfied with the Telford foundations. In many cases a combination of gravel and macadam has been employed, in which gravel was the foundation for macadam surfacing. The widths of the roads vary from 12 to 24 ft., but the prevailing width for country roads seems to be 15 ft. The depths vary from 6 to 10 ins.

On an average gravel roads cost less than stone roads. Up to Dec. 1, 1902, 415 miles of road had been constructed at a total cost of $3,802,600, thus giving an average of $9,160 per mile. The average cost per mile for the years 1901 and 1902 was $6,390, the construction being much lighter than formerly.

NEW JERSEY.

When a road improvement is to be made in New Jersey, if the owners of two-thirds of the land fronting on that road will undertake to pay 10% of the cost of improving such road, it is the duty of the board of chosen freeholders of the county in which the same is located to cause such improvement to be made. The board chooses an engineer to make the surveys and a supervisor to superintend the construction of the road, and its future maintenance. The Commissioner of Public Highways is the State official who is general superintendent of the road construction, and he (with the Governor) apportions the State appropriation among the various counties. After deducting from the cost of construction the 10% to be paid by the fronting property owners, 33% of the remainder is paid by the State and 66% by the county. The roads thus improved are known as county roads, and must be kept in repair by the county.

By act of the State in 1899, a relation was established between the towns and the State similar to the one just described between the counties and the State. The assessments within a county or town for the improvements of roads must not exceed one-fourth of the "ratables of the county," i. e., of the assessed valuation. The annual State appropriation for road improvement for 1891 was $20,000; 1892-1894, $75,000; 1895-1898, $100,000; 1899-1901, $150,000; and 1902, $250,000.

The materials recommended for road construction are stone, gravel, oyster shells, or other good materials. Stone roads have been constructed in the northeastern part, across the center and in the western part of the State. The widths vary from 10 to 30 ft., and the depths from 4 to 14 ins. The common widths are 10 to 14 ft., and the common depths are 6 to 8 ins. The cost of construction depends so much upon cost of haulage, amount of excavation, and the expense for drainage that we can only say that the cost of State aid roads ranges from $4,000 to $9,000 per mile, and averages about $6,000 per mile. Unlike the experience in Massachusetts with Telford foundations, New Jersey has used them a great deal, with much success. The objection to Telford is its increase in cost over macadam.

Gravel roads have been built across the center, along the Atlantic shore, and in the southern part of the State. They vary in width from 10 to 24 ft., the common width being 12 to 14 ft. The depths vary from 6 to 10 ins., but are commonly 8 ins. The cost of the roads vary from $1,400 to $3,500 per mile. The estimated cost on new work is usually $2,000 per mile. About 12 miles of oyster shell roads have been constructed near Salem in the southwestern part of the State. These are 10 ft. wide and 6 ins. deep, the shells having been laid 12 ins. deep and then rolled to 6 ins. The cost of these roads is estimated at $2,500 per mile.

Up to Oct. 31, 1902, some 797 miles of roads had been constructed, at a total cost to the State of $1,265,200, or about $1,590 per mile; and since the State pays one-third of nine-tenths of the total cost, the average total cost per mile was $5,300. The average cost per mile of New Jersey roads is much less than that of Massachusetts, and is probably due to four things: (1) narrower and shallower construction; (2) cheaper material, since found near at hand; (3) lower priced labor; and (4) a difference in the contract system which favors lower priced roads in New Jersey. By way of explaining this last point it may be said that in Massachusetts towns are permitted to take the contract to construct their own roads without competition, while in New Jersey competitive bids are received on all work.

CONNECTICUT.

The Connecticut Legislature in 1895 passed an act for the improvement of public roads, under which three Highway Commissioners were appointed by the Governor to apportion the State appropriation among the various towns of the State and to superintend the improvement of the highways which receive State aid. At the present time there is but one State Highway Commissioner and his term of office is four years. When a town desires to construct a road under the State Aid Law, it passes resolutions to that effect, the selectmen forwarding the same to the State Commissioner, with the plan and profile of the road. Upon approval by the commissioner the town may take the contract for the construction if for an amount less than $1,000, or it must advertise for bids if for a greater sum.

The act of the State in 1895 made the annual appropriation $75,000, and of the roads constructed under this act one-third of the cost was paid by the State, one-third by the county, and one-third by the town; in 1897 the annual appropriation was increased to $100,000, and of the roads constructed during 1897-98, half of the cost was paid by the State and half by the town. The annual appropriation in 1899 was increased to $175,000, and in 1901 to $225,000. Since 1899 the State has paid two-thirds of the cost of construction in towns having a "grand list" (i. e., assessed valuation) of over $1,000,000, and three-fourths in towns having a "grand list" of less than $1,000,000. The remainder of the cost is paid by the towns in which the roads are constructed. No sum exceeding $4,500 is to be expended in any one town in any one year. The State appropriations may be used for any form of road improvement, including grading and the building of culverts and bridges.

Gravel and broken stone are used for surfacing. The usual widths are 12 to 16 ft. with depths of 6 to 8 ins. The cost of gravel roads averages about $1,600 per mile, and of macadam about $4,700 per mile. The total lengths of the gravel and the broken stone roads are about equal; 575 miles of road have been constructed since 1895. When a road has been constructed in any town under the improvement act, such towns must thereafter keep such roads in proper repair, under the approval of the Highway Commissioner.

THE ROAD LAWS OF ILLINOIS.

BY R. I. WEBBER: (INSTRUCTOR, UNIV. OF ILL.).

ORGANIZATION.

The road law is in two general parts, one for counties under township organization, the other for counties not under township organization. Each county may elect under which form of government it wishes to act. The State was settled by people coming from different sections of the country and settling in different parts of the commonwealth. Those coming from the east brought with them the ideas and methods there in vogue, and for them has been formed the statute for counties under township organization. The others coming from the southern states, brought their laws and customs, and for their benefit has been drafted the statute for counties not under township organization. The large majority of the counties of the State are under township organization, those under county organization being in the southern portion of the State, with the exception of Cook county.

In the counties under township organization there is elected the County Board of Supervisors. Each township is entitled to one representative on this board. In towns and cities not included in the limits of the township and having a population of 4,000, there is an additional supervisor elected; two where the population is 6,500, and one for each additional 2,500 inhabitants.

In the counties under county organization there are three Commissioners elected, except that in Cook county special provision is made for the election of County Commissioners. Under county organization the county is divided into road districts, which correspond to the township in the other form of government.

The road laws for the two forms of government bear a very marked similarity, section after section reading alike, word for word. In most cases where the wording has been changed the intent remains the same. In this paper whatever is said of the one would apply to the other unless special mention is made of a difference. Under each form of government the execution of the road law is placed in the hands of a Board of Highway Commissioners, composed of three men, elected at stated times, who hold office for three years and whose term of office expires successively.

Duties of the Highway Commissioners.—The Board has almost unlimited powers over matters concerning the roads. It may levy taxes for road purposes, which may be expended in the purchase of machinery and tools, teams, real estate for township purposes, the erection of buildings, and, in fact, almost any item necessary to carry on the work of the township. They may contract for betterments, when the cost is within certain prescribed limits. They may use the power of eminent domain in case they need material to build or maintain the traveled way or for the purpose of constructing tile or open drains across private property to obtain proper drainage for the roads. They probably seldom use the power granted them to open, widen, alter or close a road, now, as the roads are very generally located and follow the section lines.

The law permits the Commissioners to employ an engineer or superintendent to take charge of the work on the roads, but usually each Commissioner supervises the work in a certain portion of the township.

When the road tax is paid in labor, the Commissioners are empowered to subdivide the township into districts and appoint for each district an overseer, who is to look after the roads and bridges in his district, give notice of and supervise the labor on the roads, collect fines and commutation money, and execute all the lawful orders of the Commissioners. The road taxes are generally paid in labor throughout the State, and the results obtained are probably as good as, if not better than, could be obtained by contract work, the relatively small amount of work and large area being taken into account.

Taxes.—Two forms of taxes are used in the State for road purposes, namely, a capitation tax and a property tax. The capitation or poll tax is used very generally throughout the State; a tax of from $1 to $2 being levied by the Road Commissioners upon every male inhabitant between the ages of 21 and 50 years. Under the county organization this tax is $1 to $5. Exempt from this tax are inhabitants of incorporated towns and villages, school directors receiving no compensation, idiots, lunatics, paupers and a few others. The poll tax may be paid in either labor or money, at the option of the person assessed, at the rate of $1.25 per day. He may either be present himself to work or send a suitable substitute.

The poll tax may be not less than one day nor more than three, providing the majority of the ballots cast at a special election are in favor of the payment of the district labor and property road tax in labor. A horse, cart, team, wagon, plow or some other necessary machinery may be required by the overseer, and in payment for this the person assessed will receive, per day, as follows: For every wagon or plow, 25 cts.; for each yoke of oxen, $1; for each span of horses, $1.25. The person required to furnish any of the above items also has to furnish a competent person to manage them.

Under the head, property tax, there are two divisions: one known as the district road tax, is levied in the district of the township and must be expended in that particular district and may be paid in labor.

The other is known as the road and bridge tax. It must be paid in cash and may be expended in any part of the township.

The Commissioners of Highways in townships operating under the cash road tax system may levy a tax of 60 cts. per $100 of the assessed valuation, and in case this levy is not sufficient, they may levy, with consent of the Auditors and the Assessor, an additional tax of 40 cts. per $100. The Commissioners of Highways under the labor tax system may levy a tax of 40 cts. per $100, and, in case of an emergency, with the approval of the Auditors and the Assessor, may levy an additional 40 cts. per $100. Half the money raised by this tax within incorporated towns and cities is paid into the treasury of that incorporation, and the incorporation may abolish the road tax within its limits. In cities of over 35,000 all the money raised by this tax is paid into the city treasury. A third form, the tax upon the traveler, is seldom used, as there are few toll roads in the State.

In many districts in the township the road and bridge tax has been continued at its limit for several years, and as a result there is a better class of roads, with many permanent bridges upon them.

Bridges.—Bridges may be erected or repaired by the Commissioners of Highways and if the bridge to be built lies across the boundary line of the township, the Commissioners of both townships may act together, and assume all responsibilities of contract, damages, etc. The expense of such a bridge is divided between the townships upon the basis of the taxable property of each township, the location of the bridge in the townships, and the advantages to be gained from it by each. The Commissioners of one township may build the bridge unaided in case the Commissioners of the other township refuse to join them. They may call for a vote on a bond issue to meet the expense of a bridge if it is larger than is available through the regular tax. Many small bridges are built by using the funds from the regular taxes, but when a large bridge is to be built a bond issue is often floated.

When it is necessary to construct a bridge, the abutments, approaches or other work necessary in its construction, county aid is afforded the township, when the cost will exceed 20 cts. per $100 on the last assessment roll and the levy of the road and bridge tax for the two years previous was for the full amount of 40 cts. per $100. The Road Commissioners may apply to the County Board for aid and the Board will appropriate from the county treasury a sum sufficient to meet half of the expense, if they find these conditions fulfilled. The Road Commissioners of the district, in counties under county organization, may apply to the County Board for aid in carrying out "distinct or expensive work" which will cost more than $100. This aid is not subject to any further conditions.

The practice under the county aid provision has departed from the original intent in many townships, and the townships are apparently benefitting themselves at the expense of the county. The county is required to grant aid when the above-mentioned conditions have existed, and a good many bridges serving, perhaps, a half dozen families, are county aid bridges. This has been made possible in that the taxes have been kept up to a certain rate or brought up to the limit, while the valuation of property for taxation has been decreased many, many times in the last few decades.

This practice has also led to undue wastefulness on the part of the Highway Commissioners. As an illustration, suppose a bridge which has sufficient span and depth of foundation could be built at a cost of $2,000. This bridge would be ample to satisfy all the necessary requirements. But the Commissioners say, "This bridge must cost $3,000 to get county aid." They, therefore, proceed to increase the span of the bridge and the depth of the abutments so that it will cost $3,000. Bids are asked for this bridge and the county aids in its erection. As a result the county is out $1,500 unnecessarily, and the township saves $500 on this selection. Thousands of dollars are thus wasted. Such a practice, by Highway Commissioners, under the supposition that they are benefitting their township, is to be most strongly condemned, and county aid should be placed under such restrictions that it could not easily take place. Four or five savings, in instances of this kind, would erect another bridge, or the much needed money could make other necessary improvements.

The writer will take this place to state that the Commissioner of Highways receives the magnificent salary of $1.50 per day. His duties may call for a drive of from 12 to 18 or more miles at a time that he can ill afford to leave his personal work. This in itself is not conducive to good results. During conversation with a Commissioner who has spent the last 21 years in office, he said that in his opinion, formed from coming in contact with other Commissioners, if the remuneration were better, a better class of Commissioners would be available. It seems probable that better remuneration and more painstaking Commisioners would bring forth better results. This criticism cannot be applied in all cases by any means.

Hard Roads.—In any township or road district in the State, a special assessment may be levied on all taxable property, including railways, for the purpose of constructing permanent roads. This may be levied up to $1 per $100, and may not be levied to exceed five years. The petition of 50 land owners asking for a vote on this levy must state the location and route of the road or roads (not to exceed two) and the rate per cent. of the tax, and number of years for which the tax shall be levied. This tax must be paid in cash into what is known as the Permanent Road Fund. The Highway Commissioners may employ a competent engineer or surveyor to make plans, specifications and estimates for this work. The work is divided into convenient sections and each section numbered.

A directory section is inserted into the law, giving width and depth of roadbed and track, and mentioning other items desirable for a well-constructed road, but the Commissioners may depart from the stated specifications if they think it desirable. Bonds from the contractor and payments to him are received and made according to the general customs in use on any work. Roads may be constructed entirely of earth when other material is not conveniently at hand, by a thorough system of tile and other drainage. All such roads are to be free roads and kept in repair by the proper authorities. In counties under county organization the petition for such roads must be signed by at least one hundred voters, who are land owners.

Town Officers.—Under the township organization the officers directly concerned with the execution of the road laws are the Supervisor and Assistant Supervisor, who are members of the County Board. As such they are interested in bridges erected under the county aid provision. The Supervisor receives and pays out all money raised in his township except for road and bridge purposes. The Assistant Supervisor is elected to represent towns and villages, under certain conditions mentioned above. He has no powers nor duties as a township officer, but enjoys a vote as a member of the County Board. Their pay is $2.50 per day when transacting business for their township outside of the township, or $1.50 per day in the township. The Township Clerk keeps the records of all town meetings, Highway Commissioner meetings and of the Board of Auditors; he also issues certificates of votes to raise money and of taxes required to the proper authorities. He receives $2.50 per day for business outside of the township and $1.50 per day in his township, also certain fees.

The Highway Commissioner has been spoken of, as has also the Overseer.

The Board of Auditors is composed of the Supervisor, the Clerk and the Justices of the Peace in the township. Their approval is required before the Highway Commissioners have the right to levy extra tax in case of emergency. They also audit the accounts of the Commissioners, Clerk and of the Supervisors. Under county organization the County Commissioners perform the same road and bridge duties as the Board of Supervisors. They receive $3 per day and mileage for all necessary travel. The Highway Commissioner has the same duties and receives the same remuneration under both forms of government. The Highway Commissioners elect one of their number treasurer and he handles all moneys raised for road and bridge purposes.

Under each form of government the execution of laws goes no farther than the limits of the county and for all the County Board has to do, it might be said that it goes no farther than the township, or its equivalent, the road district. There is, therefore, no centralization of government for the execution of the road laws in this State, each township working its own roads after its own fashion. There is a chance for considerable improvement in this direction, especially in townships that are lax in their ways.

State Aid.—At the legislative session of 1901, considerable influence was brought to bear in favor of State aid in the matter of building roads. A great deal of work was done before the session, but the bill was not even considered upon its merits in the committee. It was before the public long enough for the people to become familiar with it and it stirred up considerable opposition in all parts of the State, especially among the farmers. In the northern part of the State the opposition was caused by hard roads having been constructed without State aid, and the people in that section thought it unfair to be called upon to help build roads in other portions of the State. The central portion claimed it would be too expensive owing to there being no suitable road material in the section and their roads were in as good condition as was necessary. The southern portion, which is less wealthy than either of the other two, claimed that they could not build roads at any price, and objected to aiding other parts of the State. The bill was smothered and the fact that there was no bill presented at the last session, coupled with the present condition of popular feeling, signifies that there is little hope of passing such a bill. The people are very well satisfied with their present conditions. The interests which promoted the former bill have probably seen the trend of popular opinion and will wait for a move favorable chance to pass a bill to further their aims.

The writer would suggest that if anything is to be done by legislative action the present laws might be carefully and judiciously studied and steps taken to bring uniformity in road building, especially in sections. Such a step would, probably, not meet much popular opposition and uniformity in road building would in time be appreciated by all using the road. This end could be gained and best practice in the science of road building obtained throughout the State by centralization, and having competent road builders in charge over larger areas than are at present the rule. These larger areas could be subdivided, but all work should be done under the direction of the Board or Engineer of Highways of the larger unit.

Probably benefits might come from having all local boards or engineers under the direction of a State Board, which would suit the methods of the conditions found in the various portions of the State.

Another way in which the State might be served by its legislators would be by their rearranging or redrafting the present road laws, putting them into such shape as to be readily intelligible, and eliminating the real and seeming conflicts found in them. Sections of law relating to the road are found in many acts which have no direct bearing on the road, when they should be all grouped under one heading. A revision of this kind would be greatly appreciated by those having to do with the execution of the road laws.

ROAD IMPROVEMENT.

DISCUSSION.

MR. MELLUISH: Our novaculite roads that we put down at Bloomington four years ago have had practically no repairs made on them since they were constructed. I think that the statute with reference to "hard roads" makes no adequate provision for the repair of roads after construction so as to keep them "good roads." There seems to be provision for maintenance, but it is not obligatory, and as a result our hard roads are gradually wearing out. Those constructed near Bloomington are not as yet in specially bad shape; and they are the salvation of a great many farmers who are tributary to them, for whom they serve a useful purpose. The building of the Main St. hard road has developed a line of small properties owned by city people and used as suburban homes. There has been some agitation within the last two or three months about extending the system of hard roadways; and it looks likely that this coming summer will see more of this kind of work done. I understand that there has been an additional tax levied in anticipation of the work. We all need improved roadways. An agricultural section such as Champaign, McLean, and adjoining counties, welcome interurban roads and better transportation facilities; we also welcome good wagon roadways. Until we have them we shall not have a contented agricultural community.

I want to say a word with reference to the Brownlow bill now pending in Congress. To me it seems a very satisfactory national aid bill. Some of our States have State Road Commissions, which have taken care of the road building in their particular States, notably Massachusetts, New Jersey, and New York. About nine years ago I was identified with some of the work in Massachusetts when it was just being introduced; since then the number of improved roads which have been built there has increased to an extent such as gives courage to the engineers of Illinois in anticipation of a State or national aid plan being adopted. This Brownlow bill which is before Congress (House Bill No. 4508) ought to be brought to the attention of our members. It in no way conflicts with State aid now in vogue in some States. The bill proposes to appropriate $24,000,000, a like amount to be appropriated by the several States of this country, making up a fund of $48,000,000. It provides for the establishment of a National Bureau of Roads, under the Secretary of Agriculture. The maintenance of the roads after construction is to be by the States themselves. But the building of the roads under national supervision is to be accomplished by allotment from this appropriation according to the

MR. PARKER: I did not investigate as to any States where there was no State Aid Law. I think all the States I have mentioned had a State Aid Law.

MR. WEBBER: In Pennsylvania the counties under the Flynn Good Roads Law have entire charge of the roads.

MR. PADDOCK: Throughout the whole of the State?

MR. WEBBER: I think so.

MR. PADDOCK: They have not township subdivisions as we have?

MR. WEBBER: They have townships, but the officers of the townships do not have the same power as here in Illinois.

REPORT OF THE COMMITTEE ON RAILWAYS.

The northern part of the State seems to be given over largely to electric railways. The Rockford & Belvidere Ry. and the Rockford, Beloit & Janesville Ry. have completed their second year of operation and are doing a greater business than anticipated. Both are operating express cars and this branch of business is rapidly increasing. The Rockford & Freeport Ry. is nearing completion and the Rockford & Dixon Ry. seems to be somewhat nearer a reality than for the past few years.

The matter of franchises for carrying express and freight through cities seems to be perplexing alike to electric railways and cities. Municipal corporations usually desire to have the express brought nearer the points of delivery, which the electric line can do, but these same corporations do not feel safe in granting franchises for such purposes, fearing the "entering wedge" may get beyond control. This results in the freight being carried through toleration rather than by legal permit.

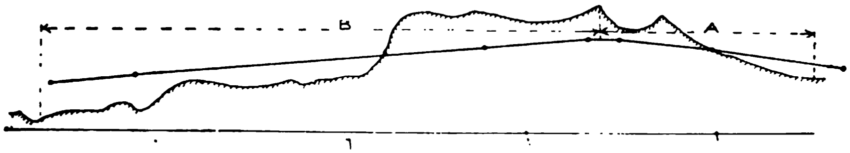
The electric lines do not seem to be old enough yet to profit by experience and seemingly have an idea that, not being steam roads, they cannot accept the experience of these roads in matters of construction. Many suburban lines still adhere to limited right-of-way and narrow roadways. Some of them are now reaping their reward. This past season being unusually wet, the ballast (usually light) has been washed away, there being no shoulders on the embankments to hold it. When an attempt has been made to widen the bank before ballast has been put on, the material has been added without stepping the slopes. This results in considerable of the added material slipping down the slope when the rains have penetrated to the surface between the old and new material.

One line not having gravel in its territory for ballast, has spent a considerable sum in hauling cinders for the purpose. The severe rains have made havoc with this material, and in some instances the embankments have been entirely cleared of ballast.

The cost of grading the lines, including bridges, averaged about $2,500 per mile. The cost of ballasting, where gravel could readily be obtained, was about $500 per mile. Where gravel could not be had and other material was substituted, the cost averaged $800 to $1,000 per mile. The narrow banks are largely responsible for the excessive cost of the ballast. The cost of the overhead work varied from $1,600 to $2,000 per mile.

The average passenger traffic for one line of about 40 miles has been for the past year 2,061 per day.

The accompanying profile represents in a general way a piece of work for a second track on one of the main lines out of Chicago. The question presented is, how should the overhaul be calculated? The material was taken from the cut as shown. Ordinarily the free-haul limits would be calculated from each end of the cut separately, and the over-haul calculated in the direction in which it was hauled. In this case the work was done with a steam shovel and small cars, the track for the cars being laid along the toe of the slope in the cut. The steam shovel began at the right and worked towards the left.



When the shovel had reached the point indicated by the vertical line in the cut, the material was taken to the left and placed in the fill to the left of the cut. This is what introduced the feature not often met with in construction. Should the overhaul be calculated as the material was actually moved or as it was supposed to have been moved; that is, determine the free-haul limit from the left end of the cut in both cut and fill, or from the left end of the cut for the fill limits and from the vertical line in the cut, for the free-haul limit for the cut. The two results were quite different in the above case and it shows a possibility in some instances of being a large "bone of contention."

CHAS. C. STOWELL, Chairman.
R. C. VIAL,
L. P. ATWOOD.
Committee.

TIES AND TIE-RENEWALS ON THE RIO GRANDE, SIERRA MADRE & PACIFIC RY.

BY L. P. ATWOOD: (MEMBER).

We have about 470,000 ties in the main line under light traffic. To date, 6½ years after construction, we have only renewed 2½%. The balance, however, are going very fast. Dry rot begins on the bottom and creeps upwards till the good part breaks. I am using dating nails and placing them approximately on the quarter point between rails on the line side.

Ties, in all cases, are of sawed long-leaf yellow pine from eastern Texas, 6x8 ins., 8 ft. long. In order to season them as well as possible, I pile them in open piles, alternately 2 and 8, and cover the pile with a roof layer of ties, laid closely together, elevating the front ends the width of one tie. The soil in which the ties rest varies from all sand or all clay to mixtures of the two, and also in the sandy portions the bank is covered with a soft, air-slacked lime formation known as "calichi." I believe dry rot grows faster in the sandy soils containing some clay, next in the sand containing the lime, and least in the clay soil. I am not at all sure of this yet. Am using every effort to educate foremen to lay ties with rings of growth concave to ground in order to retard this holding moisture.

RAILWAY CONSTRUCTION IN ILLINOIS, 1903.

BY E. E. R. TRATMAN: (MEMBER).

During the year 1903 about 250 miles of railways were built in the State of Illinois, some of this by 13 companies, while throughout the United States 380 lines built 5,700 miles. Some of the work in Illinois was as follows:

Chicago & Eastern Illinois Ry.:	
Findley to Pana—20.	
Woodland to Villa Grove—62	82 miles
Chicago & Northwestern Ry.:	
Mayfair to Lake Bluff (Chicago Northern Ry.)	22 miles
Chicago, Burlington & Quincy Ry.:	
Concord to Jacksonville—10.	
Fenton and Thompson Cut-off—(only a small part)—3	13 miles
Chicago, Milwaukee & St. Paul Ry.:	
Ashdale to Elmer—15.	
Steward to Ladd (Rochelle & Southern Ry.)—37	52 miles
Illinois Central Ry.:	
Groves to Sand Ridge—17.	
Mounds to Olive Branch—10.	
Christopher to Ziegler (Christopher & Herrin Ry.)—5.	
Gale to Thebes—1.	
Reeseville to Golconda—17	50 miles
Illinois Valley Belt Ry.:	
Peoria to Pekin	11 miles
Marquette, Spring Valley & Northwestern Ry.:	
Spring Valley to Marquette	5 miles
Toluca, Marquette & Northern Ry.:	
Henry Junction to Broadus—5.	
McNair to I. I. & I. Ry Crossing—1	6 miles
Total	243 miles

There has, as usual, been a large amount of improvement work carried on by the existing lines, and some notes of this work are given herewith:

ATCHISON, TOPEKA & SANTA FE RY. (James Dun, Chief Engineer.)—The most important work has been the joint track elevation work in Chicago, between 18th St. and Ashland Ave. This has been substantially as follows: There were six tracks raised an average of 10 ft. for about half a mile. New steel bridges were erected over four subways to accommodate six tracks each, and over one subway having one track, containing altogether 1,616 tons of metal. The bridges over the four subways were provided with floors of creosoted planking, on which is laid a bed of ballast. Four subways were graded and paved with brick on a concrete foundation and were provided with concrete curb and cement sidewalks; one of them (22nd St.) was provided with a new 3-ft. brick sewer, some 500 ft. long. Concrete abutments were constructed in two of the subways, Canal St. and 22nd St., the abutments for the other subways having been constructed in 1902.

Outside of this the only important construction work done on the Illinois Division, was the replacing of pile bridges with arch culverts, and the replacing of the light spans of the Illinois River bridge by heavy spans, including the new draw. There was no new construction, no grade and alinement improvements of any extent, and no double tracking, but 15 pile bridges were replaced with either masonry arches or girders on masonry.

BALTIMORE & OHIO RY.—No important improvement work has been done in this State during the year. The work of double tracking, and grade and alinement improvements were completed on that end of the system about two years ago, and the road is now taking advantage of the improvements made at that time.

CHICAGO & EASTERN ILLINOIS RY. (W. S. Dawley, Chief Engineer.)—This company has located two cut-offs to form a part of the main line Chicago to St. Louis, which, together with the new cut-offs being built by the Cleveland, Cincinnati, Chicago & St. Louis Ry. for the joint use of these two companies between Hillsboro and Mitchell, will give a St. Louis line 290 miles in length. These cut-offs consist of the following lines:

Woodland, Iroquois County, to Villa Grove, Douglas County, 62¼ miles, on which the maximum grades are 0.4% northbound, and 0.5% southbound; maximum curvature, 2 at junction and 1 away from the junction; the total curvature outside of the junction is 16 21′. On this line several large culverts and several concrete abutments have been put in. The only bridge of any considerable length is a 515-ft. steel viaduct crossing the middle fork of the Big Vermilion River and the Rantoul Division of the Illinois Central Ry.

The second piece of line is from Findley, Shelby County, to Pana, Christian County, a distance of 19.71 miles; the grades are the same as on the other division. There are two wooden trestles a little over 200 ft. in length placed where the haul of concrete material in wagons would be (it was thought), too expensive. Other than this, small concrete arches and iron pipes form the waterways.

Nothing has been done in the way of improvement of grades or alinement in the State of Illinois; neither has any double tracking been done in the State, but the road has double tracked in Indiana, reducing grade of 0.5% northbound to 0.35%.

Bridge renewals have been rather limited, owing to the construction of these lines, and the construction of new shops at Danville.

CHICAGO & NORTHWESTERN RY. (E. C. Carter, Chief Engineer.) —The new construction has been as follows: Chicago Northern Ry., double track, 22.2 miles; from a connection with the Chicago cut-off, of C. & N. W. Ry., at a point 1¼ miles north of Mayfair, Cook County, to a connection with the main track of the Milwaukee Division at Lake Bluff, Lake County. The line is completed.

There has been no grade and alinement improvements and no double tracking. The extent of bridge renewals was an amount of work which is classed only as ordinary compared with former seasons, the majority of structures in the State of Illinois now being permanent, with the exception of those on unimportant branch line. No important new bridges were built in either steel or concrete.

CHICAGO & WESTERN INDIANA RY. (E. H. Lee, Engineer.)—The principal improvement work in progress during the year has been the elevation of the tracks of the company, under an ordinance passed by the City of Chicago, which requires the elevation of all of the tracks of the company between 73rd St. and 18th St. The portion of the work completed during 1903 extends from 73rd St. to 55th St., a distance of two miles. In this territory approximately 16 miles of single track were elevated, and the work included the construction of a team track yard and a freight station at Englewood, between 64th and 66th Sts. A new passenger station was also erected on 63rd St. This work was begun about the middle of May, and stopped in December for the winter. The South Chicago yard of the Belt Ry. was enlarged during the season by the addition of approximately 5 miles of tracks.

CHICAGO, BURLINGTON & QUINCY RY. (W. L. Breckenridge, Chief Engineer.)—The new construction in 1903 included the line from Concord to Jacksonville, 10.16 miles; while a small portion of the work on the Fenton and Thompson Cut-Off was done. The most important bridge work was the 75-ft. concrete-steel arch at Plano, Ill., replacing a steel deck bridge over the Big Rock Creek. The new bridge is 212 ft. long and 44 ft. wide, having long wing walls on either side, which are tied together by angle iron ties embedded in concrete to form beams about 12 ins. square. The arch has a radius of 43 ft. in the barrel and 20 ft. at the haunches. The concrete alone is figured as of sufficient strength, but is reinforced by longitudinal and transverse steel bars near the inner and outer faces. The arch concrete is composed of 1 part Portland cement, 2 parts sand and 4 parts stone, while for the rest of the work the proportions are 1 to 3 to 6. The arch was built up into the old trusses, holes being left for the steel members, which were boxed in with wood. When the arch was completed, blocking was built upon it to carry the tracks and the steel trusses were removed. The holes in the arch were then filled up, and gravel filling deposited over the arch and between the spandrels and wing walls, so as to form an unbroken ballasted roadbed.

ILLINOIS CENTRAL RY. (A. S. Baldwin, Engineer of Construction.)—The work done by the Construction Department of this company in the State of Illinois during 1903 has been confined to the following:

1st.—New Lines.

A. From Groves, near the south line of Perry County, to Sand Ridge in Jackson County, a distance of 17.2 miles; shortening the present route via Murphysboro about 7 miles and giving a line with grades not exceeding 0.5%.

B. From Olive Branch in Alexander County, to Mounds in Pulaski County, distance 10½ miles. These two lines in connection with running rights over the track of the Chicago & Eastern Illinois Ry. between Thebes and Olive Branch, form a loop, south from Pinckneyville, making it possible to relieve the main tracks from Du Quoin and Carbondale to Mounds and substituting a line with grades of 26 ft. per mile for one with grades of 46 ft. per mile.

C. Christopher & Herrin Ry., constructed from Christopher in Franklin County, south 5 miles to the new mining town of Ziegler.

D. From Reeseville, in Johnson County, east 17 miles to the Ohio River at Golconda in Pope County. This line was opened early in 1903.

2nd.—Grade and Alinement Improvements.

Between Gilman and Clinton, grades have been reduced from a maximum of 53 ft. per mile to 26 ft., involving work upon 13.5 miles of line. Between Clinton and Springfield, grade reduction was begun in 1902 and completed this year, involving work upon 8.8 miles of line and the construction of 2.3 miles on a new location. This new line reduced the maximum grade of 58 ft. per mile on the original track, to 26 ft. per mile on the new. Between Belleville and Pinckneyville, a distance of 47 miles, grade reductions are under way and will be completed on 22 miles, reducing the present maximum of 40 ft. per mile to 26 ft.

ILLINOIS, IOWA & MINNESOTA RY. (I. W. Troxel, Chief Engineer.)—This is a new line, to run from Momence to Rockford, and eventually to Dubuque, Ia., having a length of about 175 miles. Of this, 120 miles are located, 25 miles under contract (near Aurora), and 15 miles graded.

INDIANA, ILLINOIS & IOWA RY. (E. A. Handy, Chief Engineer.)—There was no new construction, grade and alinement improvement, or double tracking. About 700 lin. ft. of wooden bridges were renewed, and 846 ft. rebuilt over the Vermilion River, the old trestle having been blown down by a cyclone. The only important new bridge was a plate girder structure of 536½ ft., built over the river at Kankakee. This has eight spans, two of 61 and six of 68 ft. to 70 ft. The bridge is 50 ft. above the water.

ANNUAL REPORT OF THE EXECUTIVE SECRETARY-TREASURER.

For the Year Ending Dec. 31, 1903.

To the President and Members of the Illinois Society of Engineers and Surveyors.

GENTLEMEN: I have pleasure in reporting a satisfactory state of affairs as to finances and membership. The books have been submitted to the Executive Committee, and a summary of the receipts and expenditures is as follows:

Receipts—	
From former Secretary	**$ 45.97**
Annual dues	**318.00**
Entrance fees	**21.00**
Sale of books	**29.00**
Advertisements	**438.28**
Total	**$852.25**
Expenses—	
Printing and distributing Proceedings	**$314.97**
Printing bill heads, circulars, etc	**92.30**
Secretary	**150.00**
Stamps, express and freight	**77.70**
Stenographer, Aurora meeting	**29.40**
Miscellaneous	**35.20**
Total	**$699.57**
Balance in bank Dec. 31, 1903	**$152.68**
Balance in bank Jan. 20, 1904	**$206.34**

There is due to the Society $12 for advertising, and $110 for dues of 1903.

During the year ending Dec. 31, 1903, there have been five members lost by resignation, and 10 new members elected, 6 of the latter being city engineers. This gives a net membership of 118. Of these there are still 29 who have not paid their dues for 1903, in spite of repeated statements of their accounts and personal letters being written to them. Your Secretary would call attention to the fact that annual dues are payable in advance, and as the Society has to pay its way as it goes, he would urge upon the members the desirability of prompt payment. The names of the new members and members resigned are as follows:

NEW MEMBERS.

BURDICK, C. B.	**Hartford Building, Chicago.**
DAVISON, J. A., City Engineer	**Polo**
EWALD, F. G., Cons. Engineer to Railway Commission	**Springfield**

Gearhart, O. L., City Engineer	Champaign
Hancock, F. L., City Engineer	Quincy
Kemp, J. E., City Engineer	Kewanee
Malcolm, C. W., Instructor U. of Ill	Champaign
Parker, L. G., Instructor U. of Ill	Champaign
Prout, C. A., City Engineer	Wheaton
Sawyer, D. H., City Engineer	Paris

RESIGNATIONS.

G. A. Brown, H. B. Kirkpatrick, L. E. Fischer, Walter Parmley, W. G. Potter.

There have been 1,500 copies of the Proceedings for 1903 printed, and copies have been sent to every member and advertiser, to the fellow societies with which exchanges have been arranged, and also to the following libraries:

American Society of Civil Engineers	New York, N. Y.
Western Society of Engineers	Chicago, Ill.
American Waterworks Association	Elmira, N. Y.
U. S. Geological Survey	Washington, D. C.
Railroad Commission of Illinois	Springfield, Ill.
Chicago "Tribune"	Chicago, Ill.
Illinois State Library	Springfield, Ill.
Chicago Public Library	Chicago, Ill.
New York Public Library	New York, N. Y.
John Crerar Library	Chicago, Ill.
Library of Congress	Washington, D. C.
" " University of Chicago	Chicago, Ill.
" " " " " Illinois	Champaign, Ill.
" " " " " Wisconsin	Madison, Wis.
" " " " " Michigan	Ann Arbor, Mich.
" " Purdue University	Lafayette, Ind.
" " Cornell University	Ithaca, N. Y.
" " Washington University	St. Louis, Mo.

The societies with which exchanges were arranged were as follows:

Connecticut Society of Civil Engineers.
Michigan Engineering Society.
Indiana Engineering Society.
Iowa Engineering Society.
Engineering Association of the South.
Memphis Engineering Society.
Purdue Society of Civil Engineers.
"Technograph", University of Illinois.
"Technic", University of Michigan.
Association of Ontario Land Surveyors.

There has been considerable correspondence maintained during the year, and letters have been sent to all City Engineers, County Surveyors and Waterworks Superintendents of Illinois, inviting them to join the Society. With these letters were sent forms of application for membership and blank forms for names and addresses to be used in the revision of the Directory of Engineers and Surveyors which is published in the Proceedings.

The first notices of the annual meeting were accompanied by return postal cards for members to state whether they would attend the meeting. Out of the 128 members only 23 sent back the cards, so that it was impossible to determine how many to plan for in arranging the excursion or in asking for special railway rates.

If members will show their interest by taking part in the Proceedings, helping in the work, and paying their dues promptly, there is every reason to expect that a very flourishing condition will be maintained. But the members must do their share and not leave it all to the officers.

E. E. R. TRATMAN, Secretary and Treasurer.

THE DANVILLE EXCURSION.

The excursion to Danville, which is noted in the report of the proceedings of the convention, was of special interest, and the following information regarding the plants visited will be of interest alike to those who did and those who did not take part in the excursion. It is condensed from detailed articles in the "Engineering News" of January 14 and April 28, 1904:

Filter Plant and Waterworks.—The Danville Water Co. has recently rebuilt its dam, built a mechanical filter plant, increased the pumping capacity, and made other improvements. The planning and execution of these improvements was intrusted to Mr. Daniel W. Mead, M. Am. Soc. C. E., Consulting Engineer, of Chicago, and the dam and hydraulic work was under the supervision of Mr. H. M. Ely, Resident Engineer, who has described this in a paper on page 36. The operation of the works is under the charge of Mr. G. B. Sidelinger, Superintendent of the Danville Water Co.

The supply is taken from the north fork of the Vermilion River about two miles above the city. The water is of fairly good quality, but at times it becomes very muddy, and the purpose of the filter plant is mainly to remove the suspended matter rather than to remove any large proportion of bacteria.

A 20-in. suction main extends from the intake at the dam to the pumping station. When the water is clear it can be pumped directly to the filter plant, but when dirty it is pumped through an 18-in. main 600 ft. long to a settling basin of 6,000,000 gallons capacity. From this a 12-in. gravity main runs back to the pumping station, and here the water is delivered to the coagulating basins. From these it passes to the filters, and the effluent flows to a 20-in. collecting main from which it passes to the clear water reservoir or storage reservoir. From this a 20-in. main leads to the suction well of the pumps for the distribution service, but connections are also made to enable the water from the collecting main to be delivered direct to the suction well if required. (See plan on page 38.)

The filtration and pumping plants are contained in one building, with a wing for the boilers. There are eight filter basins, in two rows, separated by the pipe chamber. The basins are 27x12⅔ ft. at the top and 8 ft. deep, but at the level of the sand (4 ft. below the top) there is a 12-in. bench reducing the size to 25x10⅔ ft. On this bench is an iron trough into which the water from the coagulating basins is delivered, and when the filters are cleaned by a reverse flow the dirty water flows from the filter beds into these troughs, and is drawn off by drain pipes to a sewer connection. Each filter bed consists of 8 in. of crushed quartz covered by about 4 ft. of finer washed silica sand. The normal depth of water over the sand is 3 ft., and the discharge is regulated by a Weston effluent regulator. At the bottom of the bed is the brass manifold for drawing off the filtered water, with the pipes for washing the sand. For washing, a current of filtered water is forced up through the bed by a Lawrence centrifugal pump, and at intervals the sand is agitated by jets of air at 3 lbs. pressure. The concrete for the filter, coagulating tanks, sedimentation tanks, etc., is composed of 1 part Owl brand Portland cement, 2½ parts sand, and 5 parts crushed limestone.

The coagulant is composed of solutions of lime and sulphate of iron, prepared in four concrete tanks in the basement of the filter house. From them the solutions are pumped to two elevated tanks, and fed by gravity to the main which enters the coagulating basins, the flow of the chemical solution being controlled by a valve with graduated disk. It is specified that the cost of coagulant required to obtain the necessary degree of purification shall not exceed $1.10 per million gallons with water of average turbidity or $1.65 with water of maximum turbidity. The water, after receiving the coagulant, flows to two coagulating or sedimentation basins outside the building. These are concrete tanks sunk in the ground, and covered with conical roofs. Each tank is 35 ft. diameter and 20 ft. deep with a capacity of 125,000 gallons. At the normal rate of flow this allows two hours for sedimentation before the water passes to the filters. Water flows directly through these tanks by gravity to the filters. From these, it goes to the clear-water reservoir, 100 ft. diameter, with a capacity of 750,000 gallons.

The capacity of the plant is 6,000,000 gallons per day, at the rate of 125,000,000 gallons. The four beds now in use give a total daily capacity of 3,000,000 gallons. The plant is guaranteed to reduce the bacteria at least 97 per cent. when the water contains over 3,300 bacteria per cu. cm.; but when the raw water contains less than this, the filtered water must not contain more than 100 per cu. cm. The filtered water must show no acid reaction, no trace of coagulant, and no increase in iron or alumina, or in alkalinity.

The contract for the buildings, filters, coagulating basins, reservoirs, etc., was awarded to W. W. Davies & Co., of Louisville, Ky., and the strainer and pipe system of the filters was put in by the New York Continental Jewell Filtration Co., of Chicago.

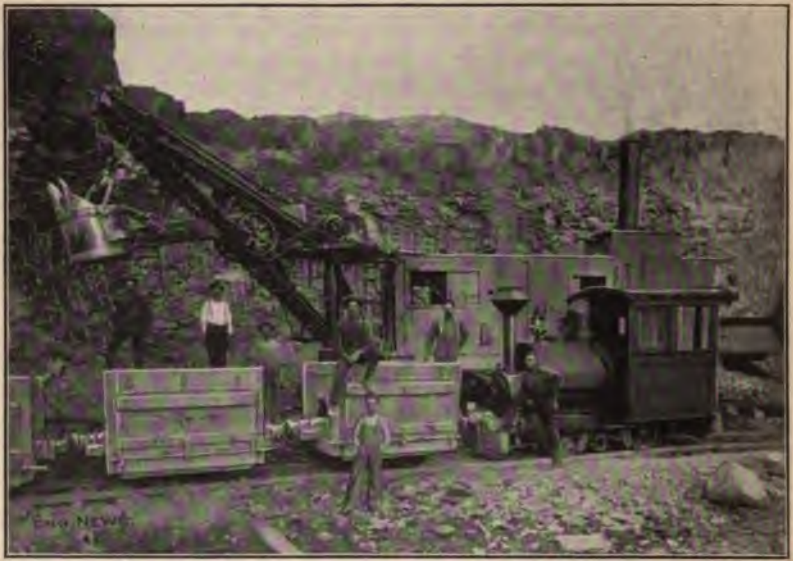
The new pumping engine is of the high-duty, cross-compound, condensing, horizontal type, with a daily capacity of 5,000,000 gallons, and is designed for a domestic pressure of 95 lbs. and a fire pressure of 125 lbs., with a steam pressure of 135 to 150 lbs. The engine has a 17-in. high-pressure cylinder, 36-in. low-pressure cylinder, and two 12½-in. double-acting outside center-packed plungers, with a common stroke of 36 ins. The piston speed at rated capacity is 280 ft. (or about 46⅔ revolutions) per minute. Efficiency tests have shown very satisfactory results. The guaranteed duty was 130,000,000 ft.-lbs. per 1,000 lbs. of dry steam when run at 5,000,000 gallons capacity (12 hours' test), or 120,000,000 ft.-lbs. when run at 2,500,000 gallons capacity. It was first tested at half capacity for a run of seven hours. The average duty at half speed was 126,457,600 ft.-lbs. for 1,000 lbs. of dry steam. A second test was made with a run of six hours at a rate of about 4,500,000 gallons per day, and the average duty was found to be 131,394,000 ft.-lbs. This engine was built by the Snow Steam Pump Co., of Buffalo, N. Y.

Western Brick Works.—These works have a capacity of 200,000 brick per day, about 300 men being employed. Both paving and building brick are made, and the latter include an impervious vitrified building brick, from which smoke and dirt will be washed by rain. This is specially suitable for railway stations and shops and buildings in smoky localities. The plant was designed by Mr. F. W. Butterworth, general manager of the Western Brick Co.

The site of the works is peculiarly advantageous in that the bed of shale used for the brick (20 to 75 ft. thick) is underlaid by a 6-ft. vein of coal, affording fuel for the kilns. The bottom of this vein is about 30 ft. above the river, so that there is excellent natural drainage.

The surface covering of clay and gravel, 3 ft. to 35 ft. thick, is removed by means of powerful jets of water. For this work a pump with a capacity of 3,000,000 gallons per 24 hours is installed on the river bank, and a 10-in. main carried to the bluff and across the top of the work to the point to be cleared. Two branches are laid, each ending in a 2½-in. "giant" or nozzle, when the pressure is about 125 lbs. The displaced material is washed into flumes and carried down to the bottom lands.

For excavating the shale, two steam shovels are employed, one in each pit. The shale is loaded into side-dump cars of 3 cu. yards capacity, running on tracks of 3-ft. gauge, and hauled by small locomotives from the shovel to the foot of a rope incline of 25%. The shale dumped from the cars goes to a set of six dry pans, and then passes down inclined screens to two pug mills, in which it is tempered by the addition of water. A "soft-mud" machine is used for making face brick, but the bulk of the output is made by two brick machines, each having a capacity of 85,000 brick per day. One of these makes paving brick and the other makes building brick. Each of these machines delivers a bar of clay about 15 ft. long, 9¼x4⅜ ins. in section, and this passes through a wheel having wire spokes which cut the bar into blocks or bricks. The speed of the wheel is regulated by the weight of the clay bar by means of a friction device, and the wheel is set at such an angle to the bar as to insure a straight cut. The paving bricks are passed through four repressing machines, which consolidate them under a pressure of 15 tons per sq. in.



SHALE EXCAVATOR AND CARS.

The brick are then put on iron trucks and sent to the drying house, which has 38 tracks 125 ft. long. The temperature at the receiving end is about 125° F., and increases to about 212° F. at the delivering end. From 36 to 48 hours are consumed in this house, the slow movement and gradual increase in temperature being necessary to allow the bricks to be thoroughly warmed and dried from the inside. Two exhaust fans draw off the moist air through gratings at the bottom of the ovens. The brick are then ready to be burned. There are 50 circular dam-draft kilns, 28 ft. diameter and 7 ft. high, each holding 75,000 bricks. Each kiln is heated by a number of coal fires in fireholes around the circumference, while the heated air is drawn down through the stacked brick into a system of conduits and thence discharged into the air through brick chimneys. About ten days are required for burning, a temperature of about 2,000° F. being maintained, and the end of the process being determined by measuring the shrinkage of the stack of brick through a hole in the top of the kiln.

After the brick have been thoroughly burned, which requires about ten days, the kiln is kept at a temperature of about 1,800° for five days, and is then cooled off. The heat is utilized and the cooling hastened by drawing cold air through the kiln, the air thus heated being then delivered to the drying room. This is effected by underground conduits, with connections to each kiln, and the air current is formed by a 320-in. fan. The cooling takes about seven days, making about 24 days in all, including the filling and emptying of the kiln.

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(Those marked with a star [*] are members of the Illinois Society of Engineers and Surveyors.)

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*Jos. O'Brien, Co. Surv.
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MARION—Lewis Pulley.
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NEWTON—Wm. Kilgore.
NORMAL—G. B. Herrington.
OGDEN—E. D. Harshberger, Asst. Eng., C. & E. I. Ry.
OLNEY—Bryant Higgins.
  Frank Nuding.
ONEIDA—M. G. Voris.
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OREGON—Thomas Jakeman.
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  T. D. Brooks.
  G. V. Dole.
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PEORIA—Daniel Allen.
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  Hobart Hamilton, C. E. and Dep. Co. Surv.
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Morgan Brooks, Prof. El. E., U. of Ill.
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Geo. Galusha.
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Edgar Williams.
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J. S. Vallette.
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YORKVILLE—*O. Dolph.
ZIEGLER—C. C. Whittier.
ZION CITY—W. J. Atkinson, Chief Eng. Z. Cy. Land Co.

CHICAGO ENGINEERS AND SURVEYORS.

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W. L. Abbott	Chief Eng., Chicago Edison Co.
Geo. T. Adams	C. E. and Surveyor, 7120 Princeton Ave.
A. H. Aldinger	Supt. of Cons., Wells Bros., Monadnock Block
H. C. Alexander	112 Clark St.
Andrews Allen	Wis. Bge. & Iron Co., Monadnock Block
H. A. Allen	Allis-Chalmers Co.
*W. H. Allen	East Chicago Co., 401 La Salle Station
Harold Almert	El. Eng., 1706 Dewey Place
*J. W. Alvord	Consulting Engineer, 127 Hartford Bldg.
G. E. Amory	Eng. for Structural Steel, 108 La Salle St.
C. G. Armstrong	Mech. Eng., Fisher Bldg.
W. C. Armstrong	Bridge Eng., C. & N. W. Ry.
B. J. Arnold	Arnold Electric Power Station Co.
L. C. Arnold	Mech. Eng., 934 Monadnock Block
S. G. Artingstall	Cons. Eng., 13 So. Hamilton Ave.
C. M. Avery	Mech. Eng., Chisholm, Boyd & White
A. Von Babo	Bridge Dept., City Hall
F. L. Bacon	Instructor, Lewis Institute
F. B. Badt	Elec. Eng., Monadnock Block
F. H. Bainbridge	Bridge Dept., Ill. Central Ry.
A. G. Baker	Div. Eng., C. M. & St. P. Ry.
A. S. Baldwin	Eng. of Cons., Ill. Central Ry.
John P. Ball	Res. Eng., C. & E. Ill. Ry.
W. D. Ball	Cons. Eng., Merchants Loan & Trust Bldg.

W. D. Barber	Dept. Public Works, City Hall
F. W. Barker	Kenwood Bridge Co.
M. K. Barnum	Supt. M. Power, C. R. I. & P. Ry.
J. W. Barrie	Asst. Eng., Pennsylvania Lines
G. B. Bartlett	Chief Draftsman, Ill. Steel Co.
F. Bartmes	Civil Engineer, 164 Dearborn St.
O. Bates	Bates & Rogers Const. Co., Manhattan Bldg.
H. G. Bauer	Civil Engineer, 63 Market St.
E. H. Beckler	Winston Bros. Co.
A. Bement	Mech. Eng., 218 La Salle St.
A. J. T. Bennett	Kenwood Bridge Co.
J. G. Bergquist	Cement Dept., Illinois Steel Ct.
R. Bernhard	Chief Draftsman, Allis-Chalmers Co.
C. E. Billin	Mech. Eng., 205 Goethe St.
C. O. Billow	Cons. Mech. Eng., 315 Dearborn St.
G. H. Binkley	Engineer for Kohler Bros., Fisher Bldg.
E. Bivert	Mechanical Engineer, 1763 Monadnock Block
E. S. Black	Mechanical Engineer, 143 Dearborn St.
Wm. Black	Chief Engineer, South Side Park Commission
C. F. Blake	Mechanical Engineer, 383 40th St.
Albert Blauvelt	Fire Protection Engineer, New York Life Bldg.
T. A. Blenkinsop	Illinois Tunnel Co.
J. C. Bley	City Engineer's Office
J. E. Blunt	Cons. Eng., C. & N. W. Ry.
H. P. Boardman,	Savage Construction Co., 188 Madison St.
J. E. Bond	Mech. and Hyd. Eng., 159 La Salle St.
F. Borg	Vierling, McDowell & Co.
H. S. Bowen	Mechanical Engineer, Rookery Bldg.
James Brady	225 Dearborn St.
J. T. Bransfield	2020 W. 39th St.
Louis Braubach	13 N. Jefferson St.
W. L. Breckenridge	Chief Eng., C., B. & Q. Ry.
*H. H. Bremer	Surveyor, 112 Clark St.
G. H. Bremner	Eng. of Ill. Lines, C., B. & Q. Ry.
Geo. S. Brigham	Civil Engineer, 143 Dearborn St.
G. M. Brill	Cons. Mech. Eng., 204 Dearborn St.
W. I. Brock	Mechanical Engineer, 79 Dearborn St.
J. H. Brown	Board of Local Impts., City Hall
M. L. Brown	Electrical Engineer, 1094 W. Madison St.
John Brunner	North Works, Illinois Steel Co.
Loren Bugbee	Mechanical Engineer, 520 Monadnock Block
*C. B. Burdick	127 Hartford Bldg.
R. O'S. Burke	Harbor Engineer, City Hall
C. E. Burnap	Mechanical Engineer, 1164 Monadnock Block
Joseph Buker	Asst. Supt. Machy., Illinois Central Ry.
T. Buskirk	Civil Engineer, 154 Lake St.
H. M. Byllesby	Electrical Engineer, Merchants Loan & Trust Bldg.
A. J. Caldwell	Mechanical Engineer, Crane Co.
H. L. Canman	Surveyor, Room 408, 112 Clark St.
Henry Campbell	Civil Engineer, 240 La Salle St.
C. J. Carlson	Telephone Engineer, 203 Washington St.
G. H. Carlson	Surveyor, 115 Dearborn St.
C. W. Carman	Mechanical Engineer, 90 La Salle St.
Wm. Carroll	Electrical Engineer, City Hall
C. H. Cartlidge	Bge. Eng., C., B. & Q. Ry.
B. B. Carter	Cons. Mech. Eng., Monadnock Block
E. C. Carter	Chief Eng., C. & N. W. Ry.
P. M. Chamberlain	Professor, Lewis Institute

O. Chanute	Cons. Eng., 413 E. Huron St.
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Durand Churchill	Cons. Mech. Eng., 147 Wabash Ave.
F. H. Clark	Supt. M. Power, C., B. & Q. Ry.
G. L. Clausen	C. E. and Surveyor, 164 La Salle St.
T. W. Clayton	Asst. Eng., C. & A. Ry.
Geo. Cole	Asst. Eng., Illinois Central Ry.
J. A. Cole	Old Colony Bldg.
J. P. Coleman	Asst. Eng., Illinois Central Ry.
Emmons Collins	Mechanical Engineer, 18 W. Randolph St.
S. C. Colton	Fitz-Simons & Connell Co., Tacoma Block
T. L. Condron	Cons. Eng., Monadnock Block
E. L. Cooley	Sanitary District
Lyman E. Cooley	Consulting Engineer, 21 Quincy St.
H. H. Cosley	North Works, Illinois Steel Co.
Wm. Cothroll	Surveyor, 100 Washington St.
W. H. Cotton	Mechanical Engineer, 315 Dearborn St.
W. L. Cowles	Holman Tracklayer Co., Hartford Bldg.
J. B. Cox	Chief Engineer, Chicago Junction Ry.
Albert S. Crane	Prin. Asst. Eng., Sanitary District
H. S. Crocker	Asst. Erect. Man., American Bridge Co.
C. M. Cross	Min. Eng., 153 La Salle St.
M. J. Cross	Sanitary District
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L. G. Curtis	Div. Eng., B. & O. Ry.
W. W. Curtis	Cons. Eng., 204 Dearborn St.
G. W. Cushing	Mechanical Engineer, 138 Jackson Boulevard
O. F. Dalstron	Scherzer Rolling Lift Bridge Co.
G. A. Damon	Man. Eng., Arnold Electric Power Station Co.
W. L. Darling	Chief Eng., C., R. I. & P. Ry.
M. S. Darrow	Asst. Eng., Bge. Dept., C., B. & Q. Ry.
John C. Darst	760 Monadnock Block
C. R. Dart	Bridge Eng., Sanitary District
W. E. Dauchy	Supt. Heating Dept., Erie City Iron Works
F. H. Davies	88 Walton Place
F. E. Davidson	North Works, Ill. Steel Co., 50 Wabansia Ave.
G. M. Davidson	Chemist and Eng. of Tests, C. & N. W. Ry.
Carl E. Davis	188 Madison St.
W. H. Davisson	Prin. Asst. Eng. M. of Way, C., R. I. & P. Ry.
W. S. Dawley	Chief Engineer, C. & E. Ill. Ry.
C. J. Delo	Eng. M. of Way, C., R. I. & P. Ry.
M. H. Dey	Div. Eng., C., R. I. & P. Ry.
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Geo. W. Dorr	138 Washington St.
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J. J. Duffy	138 Washington St.
James Dun	Chief Engineer, A. T. & S. F. Ry.
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W. E. Dunham	Mechanical Engineer, C. & N. W. Ry.

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A. R. Eldridge	Bridge Dept., C., B. & Q. Ry.
E. B. Ellicott	City Electrician, City Hall.
G. E. Ellis	Pneumatic Signal Co., Monadnock Block.
H. N. Elmer	Trenton Iron Co., Monadnock Block.
H. L. Emerson	138 Washington St.
Louis Enright	155 Washington St.
John E. Ericson	City Engineer, City Hall.
E. T. Ericksen	Bates & Rogers Construction Co.
O. H. Ernst	Lt. Col. U. S. A., U. S. Engineer Office.
Geo. Espy	Signal Engineer, C. & W. I. Ry.
J. H. Eustace	Peoples' Gas Light & Coke Co.
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W. C. Fergus	Cons. Eng., Fisher Building.
W. H. Ferguson	Supt. of Const., Ill. Steel Co.
A. W. Fiero	Rail Insp., R. W. Hunt & Co.
W. H. Finley	Prin. Asst. Eng., C. & N. W. Ry.
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Charles Fitz-Simons	Fitz-Simons & Connell, Tacoma Bldg.
Robert Forsyth	Cons. Eng., Rookery Bldg.
C. F. Foster	Cons. Eng., Manhattan Bldg.
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H. Fox	U. S. Engineer Office.
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J. A. Fulton	Great Northern Bldg.
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Josiah Gibson	Bridge Eng., 1398 Wilton Ave.
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W. E. Grady	Sanitary District.
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B. E. Grant	Hill & Grant, Marquette Bldg.
A. Gravelle	Estimating Dept., American Bridge Co.
W. F. Graves	Asst. Eng., South Side Elev. Ry.
Elam Gray	Purdy & Henderson, Monadnock Block.
J. C. Gray	Asst. Eng., Ill. Central Ry.
*Frederick Greeley	Surveyor, Opera House Block.
*Samuel Greeley	Surveyor, Opera House Block.
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G. J. Griesenauer	Cement Tester, C., M. & St. P. Ry.
W. T. Griffith	225 Dearborn St.
E. Gudeman	Chemical Eng., 704 Rialto Bldg.
Ossian Guthrie	138 Washington St.
H. H. Hadsall	Asst. Eng., Ill. Central Ry.
E. M. Hagar	Cement Dept., Ill. Steel Co.
T. C. Hain	Eng. of Masonry Const., C., M. & St. P. Ry.
Wm. B. Hale	Eng. of Tests, Western Electric Co.

C. S. Hall	Eng. of Track Elevation, C. & N. W. Ry.
A. A. Hanson	Elec. Eng., Northwestern Elev. Ry.
J. J. Harding	Asst. Eng., Bridge Dept., C., M. & St. P. Ry.
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James N. Hatch	Structural Eng., Sargent & Lundie.
F. W. Hawks	Asst. Eng., C. & E. Ill. Ry.
F. F. Heck	Eng. of Track Elevation, Ch. Junction Ry.
S. H. Hedges	Washington Heights
P. L. Hedrick	C. E., 216 N. Central Ave., Austin
E. L. Heidenreich	Cons. Eng. for Concrete Steel Work, Rookery Bldg.
E. H. Heilbronn	607 Grand Central Station.
G. A. Heimbucher	Surveyor, 203 Dearborn St.
R. H. Heine	American Bridge Co.
Karl Hellenthal	American Bridge Co., 120 Van Buren St.
F. E. Hermanns	Joint Track Elev., 646 W. 65th St.
John W. Herrington	C. E., 92 LaSalle St.
C. H. Hettelsater	D. H. Burnham & Co.
C. D. Hill	Eng. of Bd. of Local Impts., City Hall.
F. L. Hill	Hill & Grant, Marquette Building.
M. D. Hill	Ill. Steel Co.
Geo. F. Hodkinson	C. E., 1401 Monadnock Block.
A. R. Holliday	Asst. Eng., Pennsylvania Lines.
H. L. Hollis	Rookery Bldg.
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W. L. Hope	Div. Eng., C., R. I. & P. Ry.
J. C. Hopkins	Cons. Eng., 288 Leland Ave.
Geo. T. Horton	Chicago Bridge & Iron Works.
H. E. Horton	Chicago Bridge & Iron Works.
C. W. Hotchkiss	Cons. Eng., LaSalle Station.
W. D. Hotchkiss	Asst. Eng., Bd. of Local Impts., City Hall.
*S. N. Howard	Surveyor, Opera House Block.
W. M. Hughes	Bridge Eng., LaSalle Station.
Julian S. Hull	Eng. of Const., MacArthur Bros. Co.
R. W. Hunt	Cons. Eng., Rookery Building.
L. L. Hunter	C. E., 591 43rd St.
C. H. Hurd	Mech. Eng., Armour & Co.
Watson Hurlburt	803 Monadnock Block.
W. A. Illsley	326 Reaper Block.
Geo. W. Jackson	Eng. and Gen. Man., Illinois Tunnel Co.
Lewis B. Jackson	Mech. Eng.. 138 Washington St.
S. L. Jacobson	C. E., 144 Warren Ave.
E. S. Jenison	Hydraulic Eng., 4356 Ellis Ave.
J. L. Johnson	Surveyor, 90 LaSalle St.
Thomas T. Johnston	Hydraulic Eng., Security Building.
H. C. Jones	Mech. Eng., Inland Steel Co.
E. L. Jones	Roebling Const. Co., Tribune Bldg.
*W. D. Jones	Surveyor, 127 Hartford Bldg.
J. Jordan	Asst. Eng., C., B. & Q. Ry.
Wm. J. Karner	(with Ralph Modjeski) 1742 Monadnock Blk.
W. T. Keating	Supt. of Const., Lorimer & Gallagher Const. Co.
C. L. Keller	Scherzer Rolling Lift Bridge Co.
F. P. Kellogg	2449 Indiana Ave.
E. J. Kemp	C. E., 1032 Monadnock Block.
A. S. Kent	Asst. Eng., C., I. & L. Ry.
Robert Kerr	Asst. Eng., Ill. Central Ry.
Frank C. Kettler	North Works, Illinois Steel Co.
C. S. Knapp	Mech. Eng., Pullman Car Co.

G. O. Knapp	Gas Engineer, 157 Michigan Ave.
F. J. Koza	Union Traction Co.
W. Kramer	Surveyor, 84 LaSalle St.
W. T. Krausch	Architect, C., B. & Q. Ry.
John G. Kreer	North Works, Illinois Steel Co.
Charles L. Krum	Refrig. Eng., 39 N. State St.
R. Kuntsman	Mech. Eng., 84 Adams St.
J. H. Ladd	217 LaSalle St.
Van Rensselaer Lansingh	Illuminating Eng., 211 Jackson Blvd.
E. N. Layfield	Chicago Terminal Transfer Co.
G. A. Lederle	Christie & Lowe, 171 LaSalle St.
E. H. Lee	Chf. Engineer, C. & W. I. Ry.
Henry W. Lee	Arcade Building.
Wm. Lee	Sewer Dept., City Hall
C. Lehmann	Ericson & Lehmann, Chamber of Commerce.
P. K. Leonard	441 So. Winchester Ave.
Charles Levings	6430 Yale Ave.
Almon C. Libby	84 Van Buren St.
G. A. M. Liljencranz	U. S. Engineer Office.
John H. Lindrooth	Surveyor, 426 Cleveland Ave.
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F. J. Llewellyn	Contracting Eng., American Bridge Co.
T. S. Lloyd	Gen. Supt. M. P., C., R. I. & P. Ry.
H. C. Lothholz	American Bridge Co.
Jesse Lane	Christie & Lowe, 171 LaSalle St.
C. F. Loweth	Bridge Eng., C., M. & St. P. Ry.
Geo. R. Ludwig	Monadnock Block.
N. E. Lugoff	225 Dearborn St.
W. S. MacHarg	Cons. Eng. for Intercepting Sewers, City Hall.
Charles MacRitchie	Cons. Eng., 21 Quincy St.
Wm. J. McAllen	C. E., 42 Cedar St.
Peter C. McArdle	City Cement Tester, City Hall.
John L. McCalman	131 La Salle St.
Wm. McCloy	Asst. Eng., Ill. Central Ry.
T. W. McCoy	Con. Min. Eng., 125 La Salle St.
B. McKeen	Eng. of Terminals, Pennsylvania Lines.
W. S. McKinney	M. E., Marquette Building.
C. McLennan	100 Washington St.
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D. W. Maher	Asst. Eng. Bd. of Pub. Impts., City Hall.
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J. P. Mallette	131 La Salle St.
*A. H. Marshall	(with D. W. Mead) 738 First National Bank Bldg.
A. J. Mason	C. E., 1425 Old Colony Bldg.
Geo. A. Masters	73 53rd St.
R. Y. Maxon	Asst. Eng., C. & E. Ill. Ry.
Geo. M. Mayer	Mech. and El. Eng, 1131 Monadnock Block.
*D. W. Mead	Cons. Hyd. Eng., First National Bank Bldg.
C. W. Melcher	Ingersoll-Sergeant Drill Co., 84 Van Buren St.
W. S. Menden	Chf. Eng., Metropolitan Elev. Ry.
Carl Mendius	Surveyor, 1102 Schiller Bldg.
L. T. Mensch	Eng. for Concrete Steel, 324 Dearborn St.
R. J. Mershon	Surveyor, 1317 W. 15th St.
John S. Metcalf	J. S. Metcalf Co., Womans' Temple.
E. D. Miller	C. E., 1482 Washington Boulevard.
Guy Miltimore	Sewer Dept., City Hall.
C. M. Mock	Chf. Eng., Lake St. Elev. Ry. and Northwestern Elev. Ry.
Ralph Modjeski	Cons. Bridge Eng., Monadnock Block.

Louis Mohr	**Mech. Eng., 32 Illinois St.**
W. S. Monroe	Mech. Eng., **Sargent & Lundy, 46 Van Buren St.**
J. T. Montgomery	**Roebling Const. Co., Tribune Bldg.**
E. L. Moore	**Contracting Engineer, Monon Bldg.**
L. T. Moore	Consulting **Engineer, Ill. Central Ry.**
W. Morava	Morava **Const. Co., Marquette Bldg.**
L. P. Morehouse	Cust. **of Deeds, Ill. Central Ry.**
A. M. Morgan	Hyd. and San. Eng.. Royal Insurance Bldg.
Geo. C. Morgan	**Hyd. Eng., 169 Jackson Boulevard.**
Jacob Morris	**Surveyor, 189 La Salle St.**
John C. Morrison	**C. E., 140 Dearborn St.**
E. L. Morse	**Chf. Eng., C. & A. Ry.**
A. W. Moseley	Prof. of App. Mech., **Lewis Institute.**
A. D. Mott	Ritter & Mott, **Marquette Bldg.**
Hugo Mueller	**204 Dearborn St.**
W. D. Murphy	**193 54th St.**
Edward Murray	Asst. **Eng., C., M. & St. P. Ry.**
N. Neff	**Eng. M. of Way, Pennsylvania Lines.**
T. O. Neikerk	Rogers' Ballast Car Co.. **Fisher Bldg.**
T. G. Neuffer	**Asst. Supt. Mach., Ill. Central Ry.**
C. M. T. Neville	**American Bridge Co.**
John Nichol	MacRitchie & Nichol, **27 Quincy St.**
Geo. P. Nichols	Mech. Eng., **927 Monadnock Block.**
L. A. Nichols	Chf. Eng. Ill. Valley **Traction Co., 225 Dearborn St.**
S. F. Nichols	Geo. P. Nichols & Bro,, **927 Monadnock Block.**
*Fred Norlin	**Surveyor, Opera House Block.**
W. H. North	Struc. **Eng., 4647 Prairie Ave.**
G. H. Nott	**204 Dearborn St.**
John O'Gara	**Engineer for Dolese & Shepard.**
*H. I. Orwig	C. & N. W. Ry., **20 Fifth Ave.**
Otto E. Osthoff	El. and Mech. Eng., N. Y. Life Bldg.
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Alex. Page	Surveyor, 171 **La Salle St.**
John W. Page	Page & Shnable. Security Building.
F. E. Paradis	Chf. Eng.. Chicago **Terminal Transfer Ry.**
Frank Pavlicek	Surveyor. 97 Clark St.
H. W. Parkhurst	Eng. Bridges and Bldgs., Ill. **Central Ry.**
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J. P. H. Perry	Bridge Dept., C.. **B. & Q. Ry.**
Wharton Platner	Surveyor, **100 Washington St.**
W. C. Potter	Min. **Eng., 1120 Rookery Bldg.**
N. D. Pound	Pound Const. Co., **Metropolitan Bldg.**
A. V. Powell	Cons. Civ. Eng., Chamber **of Commerce.**
W. H. Pratt	Gen. Supt.. N. Works, Ill. **Steel Co.**
*J. T. Price	C. & N. W. Ry., **22 Fifth Ave.**
J. H. Prior	Bridge Insp., 1742 **Monadnock Block.**
M. W. Priseler	Ingersoll-Sergeant Co.. Old Colony Building.
Robert Quayle	Supt. M. Power, C. & N. W. Ry.
F. E. Rainier	1510 Old Colony Bldg.
Theodore Rall	1744 Monadnock Block.
Isham Randolph	Chf. Eng., Sanitary District.
R. I. Randolph	Sanitary District.
W. McC. Rapalje	**218 La Salle St.**
W. Raslin	E. C. & R. M. Shankland, **Rookery Bldg.**
E. O. Reeder	Asst. **Chf. Eng., C., M. & St. P. Ry.**
Wm. T. Reeves	Bridge Dept., **R. W. Hunt & Co.**
A. F. Reichmann	Res. Eng., **American Bridge Co.**
E. J. Relph	Sig. **Eng., C., R. I. & P. Ry.**

Wm. Renshaw	Supt. Mach., Ill. Central Ry.
E. A. Renwick	Holabird & Roche, Monadnock Block.
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S. A. Rhodes	El. Eng., 433 N. Pine Ave.
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L. V. Rice	R. W. Hunt & Co., Rookery Bldg.
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Lewis W. Riddle	Civil Eng., 2535 Indiana Ave.
Paul K. Richter	315 Dearborn St.
John Ritchie	Civ. Eng., 256 Monadnock Block.
L. E. Ritter	Ritter & Mott, Marquette Bldg.
C. N. Roberts	97 Clark St.
V. B. Roberts	Surveyor, Reaper Block.
Warren R. Roberts	Struc. Eng., 204 Dearborn St.
E. M. Robinson	Asst. Eng., C. & N. W. Ry.
J. S. Robinson	Div. Eng., C. & N. W. Ry.
A. J. Roewade	Architect and C. E., 1493 N. Mozart St.
C. W. Rogers	Mech. Eng., 281 So. Clinton St.
F. A. Rogers	Lewis Institute.
W. A. Rogers	Bates & Rogers' Const. Co., Manhattan Bldg.
W. H. Roney	Const. Eng., 760 Monadnock Block.
W. H. Rosencrans	Arnold Electric Power Station Co.
W. H. V. Rosing	Asst. Supt. Machy., Ill. Central Ry.
*F. C. Rossiter	1004 Van Buren St.
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*Emil Rudolph	Land Surveyor, 112 Clark St.
C. H. Ruel	Chf. Eng., Chicago Heights Transfer Ry.
A. T. Sabin	Eng., MacArthur Bros. Co., Fisher Bldg.
H. R. Safford	Prin. Asst. Eng., Ill. Central Ry.
N. A. Sager	Sewer Dept., City Hall.
E. Salich	Civil Eng., 756 Monadnock Block.
Geo. F. Samuel	City Hall.
C. C. Saner	M. of Way Dept., C., R. I. & P. Ry.
O. Sanne	Struc. Eng., 1742 Monadnock Block.
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Frederick Sargent	Mech. and Elec. Eng., Isabella Bldg.
R. C. Sattley	Eng. Bridges and Bldgs., C. & N. W. Ry.
G. L. Sawyer	(with W. S. Shields) 1715 Marquette Bldg.
J. W. Schaub	Con. Eng., Monadnock Block.
Albert Scheible	El. Eng., 129 Fulton St.
*A. C. Schrader	Chf. Eng., West Park Commission, Union Park.
C. Schroeter	Civil and Min. Eng., 611 W. Congress St.
Carl E. Schulze	109 Randolph St.
C. M. Schwerin	Min. Eng., Fisher Bldg.
E. K. Scott	Civil Eng., Hoover & Mason, Old Colony Bldg.
Geo. W. Scott	Cons. Eng., Security Bldg.
G. H. Scribner	Cont. Eng., 135 Adams St.
Oscar Seaberg	with E. L. Heidenreich, 721 Rookery Bldg.
C. B. Sears	Civil Eng., 279 Dearborn St.
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Burdick, Charles B., Civil Engineer......1207 Hartford Building, Chicago
Bushnell, Web. P., Chief Engineer, Sny Id. Levee Drainage District, ...933 N. 11th St., Quincy
Byrne, Thomas S., Contractor...................308 Janssen Ave., Chicago
Canman, Harry L., Surveyor...................4513 Indiana Ave., Chicago
Carpenter, Renzo A., Engineer and Commissioner of Public Works ....Municipal Building, Oak Park
Chandler, Geo. W., City Engineer, and Gen. Man. Ill. Cen. El. Ry., Canton
Chase, Charles P., City Engineer, and President and Manager of the Iowa Engineering Co..................................Clinton, Iowa
Chipman, Paul, Assistant Engineer, Pere Marquette Ry................ ....222 Fort St. Station, Detroit, Mich.
Clark, G. M., Drainage Engineer, Woodford County.............Low Point
Clark, Joseph L., Surveyor and Civil Engineer....................Momence
Condron, T. L., Consulting Bridge Engineer, 1750 Monadnock Block, Chicago
Connolly, Frank M., City Engineer............946 So. West St., Galesburg
Crowley, John W., President, People's Construction Co...Davenport, Iowa
Dappert, James W., Civil Engineer and Co. Surv..Lock Box 141, Taylorville
Davison, J. A., City Engineer..Polo
Day, Wm. J., County Surveyor......................................Bement
Dowell, Will, Civ. Eng. and Co. Surveyor.................Coffeyburg, Mo.
Dubuis, O. F., Landscape Engineer...........1703 No. Jefferson St., Peoria
Dunn, Charles H., Civil Engineer and County Surveyor, Court House, Peoria
Elliott, C. G., Expert in Drainage, Office of Experiment Stations,...... ....U. S. Department of Agriculture, Washington, D. C.
Ely, Howard M., Resident Engineer, Danville Water Co..........Danville
Emerson, Harry L., Surveyor and Civil Engineer..................... ....1311 Chamber of Commerce Building, Chicago
Enos, Allen, Civil Engineer..................................Springfield
Enos, Z. A., Civil Engineer...................................Springfield

EVANS, WALLACE C., Civil Eng. and Contractor, 100 Y. M. C. A. Bldg., Peoria

EWALD, FRANK G., Consulting Engineer to the Railroad and Warehouse Commission .... Springfield

FEENEY, WILLIAM P., Civ Eng. & Surveyor, Room 408, 112 Clark St., Chicago

FLETCHER, PERRY E., Civil and Drainage Engineer.................Vandalia

FRINK, FREDERICK G., Asst. Prof. of Civil Engineering, University of Illinois......................................1003 Oregon Ave., Urbana

GABELMAN, JULIUS G., Civil Engineer...............96 Pierce Ave., Chicago

GATES, A. W., Secretary and Gen. Man., Monmouth Mining & Mfg. Co., ... Monmouth

GEARHART, ORVAL L., City Engineer..............................Champaign

GERBER, WINFRED DEAN, Chief Engineer, Denver, Enid & Gulf Ry., Enid, Okla.

GLUCK, LEO., Chief Eng., Spring Valley Coal Co..............Spring Valley

GORDON, DANIEL, Civil Engineer and Surveyor.......................Moline

GRAFF, JAMES G., County Surveyor............300 County Building, Chicago

GRAHAM, GEO. W., City Engineer..................................Freeport

GREELEY, FREDERICK, Surveyor.............822 Opera House Block, Chicago

GREGG, ROBERT D., City Engineer..................................Kankakee

HABERMEYER, GEORGE C., Sanitary Engineer............383 Main St., Aurora

HAGAR, EDWARD McK., Manager Cement Department, Illinois Steel Co., ...1057 Rookery Building, Chicago

HALLET, H. DOW, Consulting Engineer...............................Aurora

HANCOCK, FRED L., City Engineer....................................Quincy

HARMAN, JACOB A., Civil Engineer............109 So. Jefferson Ave., Peoria

HAY, W. M., Circuit Clerk and County Recorder..................Sycamore

HENDERSON, CHARLES R...........Apartado 113, Parral, Chihuahua, Mexico

HERRICK, GEORGE I., Engineer and Architect.........................Wheaton

HERRON, W. H., Topographer, U. S. Geological Survey....Washington, D. C.

HITTELL, JOHN B., Asst. Eng., Dept. of Public Works, 207 City Hall, Chicago

HONENS, FREDERICK WM., Jr. U. S. Engineer.........507 Fifth Ave., Sterling

HOWARD, S. N., Surveyor, and Secretary of the Greeley-Howard Co...... ....Room 822, 112 Clark St., Chicago

HOLMES, CEPHAS, City Engineer & Co. Surveyor, 331 W. Jackson St., Macomb

HUGGANS, D. E., Superintendent, Streator Aqueduct Co............Streator

IVES, FRANK W., Bridge Contractor............P. O. Box, 453, Bloomington

JACOBS, CHARLES C., Contractor.....................................Amboy

JONES, LLOYD Z., Surveyor...Galva

JONES, W. D., Civil Engineer..............1207 Hartford Building, Chicago

KEMP, J. E.......................................P. O. Box, 195, Kewanee

KETCHUM, MILO S., Prof. of Civ. Eng., Univ. of Colorado....Boulder, Colo.

KIMBALL, WILLIAM H., Civil Engineer......114 W. Third St., Davenport, Ia.

KIRCHOFFER, WILLIAM G., Consulting Engineer................Madison, Wis.

KNIGHT, PHILIP C., Drainage Engineer..............................Pontiac

LAKIN, C. C., Civil Engineer.......................................Rockford

LANG, FRANK C., Surveyor.........................90 La Salle St., Chicago

LEE, WILLIAM, Asst. Eng., Bureau of Sewers.........207 City Hall, Chicago

LEMEN, W. C........................U. S. Engineer Office, Brunswick, Ga.

LINK, RUDOLPH, Manager, Keuffel & Esser Co.....111 Madison St., Chicago

LUCKE, FREDERICK W., Thomas Moulding Co........................... ....1202 Chamber of Commerce, Chicago

MAIN, EDWIN, City Engineer.......................516 N. 2nd St., Rockford

MALCOLM, CHARLES W., Instructor in Civil Engineering, University of Illinois.......................................705 So. 6th St., Champaign

MAREAN, W. A., City Engineer.....................................Belvidere

MARR, WM. W., Civil Engineer......................207 City Hall, Chicago

MARSHALL, ALFRED H................738 First National Bank Bldg., Chicago

MARTIN, CURTIS C., County Surveyor...............................Geneseo

MAURY, DABNEY H., Consulting Engineer....129 No. Jefferson Ave., Peoria

MEAD, D. W., Consulting Engineer, 738 First National Bank Bldg., Chicago

MELLUISH, JAMES G., Civil Engineer........222 Unity Building, Bloomington

MENDIUS, CARL, Surveyor....................1102 Schiller Building Chicago
MILLER, MORTIMER R., Supt. Public Works and Civil Engineer....................109 Washington St., Waukegan
MILLER, SIDNEY W., Proprietor Pacific Flush Tank Co....................84 LaSalle St., Chicago
MONSARRAT, N. D., Chief Eng., Sunday Creek Coal Co....................432 E. Broad St., Columbus, O.
MOORE, JOS. A., Civil Engineer....................475 E. 48th St., Chicago
MCAULEY, JOHN B., Engineer and Contractor....................Galesburg
MCCLANAHAN, THOMAS S., City Engineer and County Surveyor..Monmouth
MCLANE, CYRUS D....................McManus Bldg., Davenport, Iowa
MCNABB, JOHN M., Surveyor and Drainage Engineer, Farmers' Bank, McNabb
NELSON, ALVIN E., Landscape Architect........941 Marquette Bldg., Chicago
NICHOL, A. F., Civil Engineer....................Marseilles
NICOLET, CHARLES H., Engineer of Structures and Repairs, Mathiessen & Hegeler Zinc Co....................LaSalle
NORLIN, FRED, Surveyor..........711 Chicago Opera House Block, Chicago
O'BRIEN, JOSEPH, County Surveyor....................Champaign
ORR, ROBERT E., Civil Engineer, (105 Second Ave.), 309 Barber Bldg., Joliet
ORWIG, H. I. Land Dept., C. & N. W. Ry..............20 Fifth Ave., Chicago
OSWALD, FRIDOLIN, Architect....................Alhambra
PADDOCK, HENRY G., City Engineer....................Moline
PARKER, LAWRENCE G., Instructor in Civil Engineering, University of Illinois....................705 Sixth St., Champaign
PARR, JAMES F., Civil Engineer and Surveyor....................500 Metropolitan Building, East St. Louis
PRICE, J. T., Land Dept., C. & N. W. Ry....................Chicago
PROUT, CHARLES A., City Engineer....................Wheaton
PURINGTON, D. V....................4800 Kenwood Ave., Chicago
QUADE, JOHN C., Secy. and Civil Engineer, Big Creek Coal Co....St. David
QUILTY, T. FRANK, Engineering Contractor.........6 Wabash Ave., Chicago
RICKER, N. CLIFFORD, Dean of the College of Engineering, University of Illinois .... Urbana
ROBERTS, CHARLES N., Surveyor and Civil Engineer, 709 Reaper Block, Chicago
ROBERTS, VERTUS B., Civil Engineer.............107 Washington St., Chicago
ROSSITER, F. C....................1004 Van Buren St., Chicago
RUDOLPH, EMIL, Surveyor................Room 408, 112 Clark St., Chicago
SABIN, JAY H., Asst. Eng., E. J. & E. Ry..............105 Buell Ave., Joliet
SAWYER, D. H., Eng. M. of Way, Illinois Traction System........Springfield
SAWYER, GEORGE L., Asst. City Engineer..................Boise City, Idaho
SCHMELTZER, J. FOSTER, Engineer....................Manteno
SCHRADER, A. C., Chief Engineer, West Park Board................Chicago
SEAFERT, WM., "Cement Engineering"..............164 LaSalle St., Chicago
SEELIG, EDWARD F., Instruments....................124 So. Clark St., Chicago
SHAW, WALTER A., Asst. Eng., Intercepting Sewer System....................941 Farwell Ave., Chicago
SHEPARDSON, J. E., Structural Engineer......80 Willow St., Brooklyn, N. Y.
SHERMAN, LEROY K., Civil Engineer...........6128 Lexington Ave., Chicago
SHIELDS, W. S., Civil Engineer...............1715 Marquette Bldg., Chicago
SIDELINGER, GEORGE B., Superintendent of Water Works............Danville
SIMS, LEWIS J., Drainage Engineer and Surveyor, 627 Lincoln Ave., Lincoln
SLOCUM, ROY H., Instructor in Theoretical and Applied Mechanics, University of Illinois....................926 W. Illinois St., Urbana
SNOW, T. W., Manager, The Otto Gas Engine Works....................360 Dearborn St., Chicago
STEVENS, HUBERT A., City Engineer................104 Burttison St., Joliet
STEWART, JOHN T., Drainage Engineer (U. S. Dept. of Agriculture)..Paxton
STOWELL, CHARLES C., Civil Engineer..........328 N. Fourth St., Rockford
TALBOT, ARTHUR N., Professor of Municipal and Sanitary Engineering, University of Illinois....................Urbana

Tarrant, Wm. H., Chief Engineer, Illinois Central Traction Co., and St. Louis & Springfield Electric Ry. Co. .... Springfield
Thompson, A. D., Consulting Municipal Engineer, 335 Woolner Bldg., Peoria
Tratman, E. E. R., Associate Editor of "Engineering News," .... 1636 Monadnock Block, Chicago
Troxel, Isaac W., Chief Engineer, Ill., Iowa & Minn. Ry. .... Aurora
Von Oven, Frederick W., Consulting and Contracting Engineer ...... Aurora
Waterbury, Abram D., Heating Contractor .... Polo
Waterbury, Leslie A., Instructor in Civil Engineering, University of Illinois .... 1016 Oregon St., Urbana
Webster, Arthur L., Surveyor and Engineer .... Wheaton
Westerfeld, Charles P., Surveyor .... 416 Porter St., Waukegan
Williams, Robert E., Civil Engineer ...... Room 711, 84 LaSalle St., Chicago
Windes, Frank A., Civil Engineer of the Villages of Winnetka, Glencoe and Fort Sheridan .... P. O. Box, 195 Winnetka
Withington, J., Surveyor .... 115 So. 17th St., Mattoon
Wood, Wm. Melville, Chief Engineer, Decatur Bridge Co. .... Decatur

SUMMARY.

Number of members, February, 1904	132
Number of new members (Von Oven, Dowell)	2
	134
Number of members lost by death, 1904 (Dolph, Graves, Whitley)	3
Number of members, December, 1904	131
Number of members lost since December, 1904, dropped for non-payment of dues, 19; resigned, 2 (Serviss, Vial)	21
	110
Number of new members since December, 1904	45
Total number of members, April, 1905	155

Orson Dolph
E. A. Graves
Noah Whitley

Whereas, during the year 1904 the hand of Death has taken from our ranks three of our fellow members, Mr. Orson Dolph, of Yorkville; Mr. E. A. Graves, of Streator; and Mr. Noah Whitley, of Joliet; and

Whereas, the Society desires to express its deep sense of loss at the death of these honored and respected members;

Be it Resolved, that we extend to the bereaved families our sincere sympathy in their bereavement; and

Be it further Resolved, that a copy of these resolutions be printed in the Journal of the Proceedings of this Society and a copy sent to the bereaved families.

W. M. Hay, H. A. Stevens, L. K. Sherman,
Committee.

NOTICES

ANNUAL MEETING, 1906

The Twenty-first Annual Meeting will be held at ***Rockford, Illinois,*** on January 17, 18 and 19, 1906.

A meeting of the Executive Committee will be held in October to make the preliminary arrangements.

COMMITTEES

The Committees are listed on Page 3, and cards have been sent out giving the names of the members of the several committees. The members of each committee are asked to meet or correspond with each other in regard to their plans of work, and also to assist in the preparation of the reports.

Individual papers will be welcome, and members are invited to prepare papers and so share in the work.

Papers and reports should be in the hands of the Secretary by December 31, to give time for arranging the program.

MEMBERSHIP

Members are urged to interest their friends in the Society and invite them to become members. Applications for membership may be made to the Secretary at any time.

Members receive the Proceedings of this Society and also of some eight or ten other societies of engineers and surveyors.

Entrance fee (to be sent with application),	$3.00
Annual dues, first year, - - -	2.00
Annual dues, each year after, - -	4.00

ADVERTISEMENTS

A large and varied list of Advertisements accompanies this Report, and members are asked to look these over, as being interesting and instructive as well as commercially useful.

Members are requested also to write these advertisers when wanting prices, materials or information. (See the "Classified List of Advertisements.")

When writing to them please mention that you have seen their advertisements in the Report of the Illinois Society of Engineers and Surveyors.

PROCEEDINGS

OF THE

TWENTIETH ANNUAL MEETING

OF THE

Illinois Society of Engineers and Surveyors

The Twentieth Annual Meeting was held in Chicago, January 18, 19 and 20, 1905, the headquarters and place of meeting being at the Sherman House. This was the largest and most successful meeting in the history of the Society. About 75 persons (including over 60 members) signed the register, and there were others who did not register. Over 40 new members were also elected.

JANUARY 18. AFTERNOON SESSION.

The meeting was called to order at 2:30 P. M., by the President, Mr. John W. Alvord; and a short and happy address of welcome was delivered by Mr. S. S. Greeley, honorary member of the Society, and the "dean" of Chicago's surveyors. This was followed by the annual address of the President.

The subject of drainage was dealt with at this meeting. The first paper was by Mr. J. G. Melluish, on "Drainage in Western Iowa," and this was followed by one by Mr. A. B. Alexander on "How Tile Drainage Improves a Soil." This was read by the Secretary. Mr. J. A. Harman then presented the report of the Committee on Drainage, after which there was an extended discussion. Mr. N. C. Ricker announced that the report of the Committee on Architecture had not been completed, but presented a paper on "School House Construction," by Mr. F. Oswald.

Mr. W. M. Hay moved that a Committee on Legislation be appointed, to consist of three members; this committee to report upon the proposed geological survey of the State, the good roads movement, and the proposition for the licensing of land surveyors. The motion was carried.

JANUARY 18. EVENING SESSION.

The meeting was called to order by the President at 7:15 P. M. The first paper was on "The Park System of Chicago," by Mr. A. C.

Schrader. This was followed by one on "Street Paving at Quincy, Ill.," by Mr. F. L. Hancock; it was read by the Secretary in the absence of the author. The Secretary then gave a short description of the Chicago telephone tunnel system and the freight transportation system which is to be operated in connection with it. At the close of his remarks the meeting adjourned, and the members proceeded to the offices of the Illinois Telephone Construction Co., and descended to the tunnel, where special trains were in waiting, provided by the courtesy of Mr. Geo. W. Jackson, Chief Engineer and General Manager. The central exchange of the company's automatic telephone exchange system was also visited. Some notes of the trip are given elsewhere.

JANUARY 19. MORNING SESSION.

The third session was called to order by the President at 9:30 A. M. He announced the appointment of the Committee on Legislation as follows: Prof. A. N. Talbot, to represent the subject of good roads; Mr. J. G. Melluish, to represent that of the geological survey; and Mr. W. M. Hay, to represent that of the licensing of surveyors. On motion of Mr. S. S. Greeley, it was voted that each sub-committee of one should have power to increase its number to three. On motion of Mr. E. Main, it was voted to add to the committee Mr. W. S. Shields, to represent the subject of special assessments, with power to appoint two other members of his sub-committee.

On motion of Mr. Jacob A. Harman, it was voted that a Nominating Committee should be appointed, and the President appointed Mr. H. G. Paddock, of Moline; Mr. W. S. Shields, of Chicago; and Mr. J. A. Harman, of Peoria. Mr. J. A. Harman also moved that a committee be appointed to consider the advisability of holding two additional meetings in May and September. There was some objection to this, but the motion was carried, and the President appointed Mr. C. H. Nicolet, Mr. F. A. Windes, Mr. S. S. Greeley, Mr. W. M. Hay, and Mr. J. A. Harman.

The rest of this session was devoted specially to the subject of surveying. Mr. S. Greeley first gave an address on "The History of Surveying in Chicago," which was followed by one on "Modern City Surveying in Chicago," by Mr. S. N. Howard, being read by the Secretary in the absence of the author. Other papers were read as follows: "Establishing Bench Marks in Chicago," by Mr. S. H. Hedges; "Judicial Elements of Surveying," by Mr. W. D. Jones; and "Instruction in Surveying at the University of Illinois," by Mr. L. A. Waterbury. This last was illustrated by specimens of map work done by the students. A paper by Mr. H. H. Bremer on "The Land Surveyor," was also read by Mr. Waterbury. In order to leave time for discussion, three other papers were read by title: "Land Surveying in Northern Missouri," by Mr. W. Dowell; "City Surveying," by Mr. C. C. Stowell, and "Office Methods of Railway Surveying," by Mr.

W. D. Gerber. The report of the Committee on Surveying was then read, and there was a general discussion. Mr. L. K. Sherman also described a card index system devised by him for indexing the papers, etc., in the Proceedings of this and other societies. The meeting then adjourned.

JANUARY 19. AFTERNOON (EXCURSION).

The afternoon was devoted to an excursion to the new Portland cement works of the Illinois Steel Co., at Buffington, Ind., by invitation of the company. A special car was attached to the 2:05 P. M. train on the Pennsylvania Lines, and refreshments were served on the return trip. Some notes on this point are given elsewhere.

JANUARY 19. EVENING SESSION.

The evening session was called to order by the President at 7:45 P. M. Mr. D. W. Mead first gave a talk on "Filtration," illustrated by numerous lantern slides of statistical diagrams, views and drawings of filter plants, etc. Mr. C. B. Burdick read a paper on "Accuracy Tests of Water Meters at Des Moines, Ia.," and was followed by Mr. A. M. Shaw with a paper on "The Inlet Swamp Drainage District."

The report of the Executive Board was then read by Mr. J. G. Melluish, and the Secretary presented his annual report. On motion of Mr. D. W. Mead, it was voted to appoint a committee to draft resolutions on the deaths of the three members who had died during 1904; the President appointed Mr. W. M. Hay, Mr. H. A. Stevens, and Mr. L. K. Sherman. The report of the Nominating Committee was handed in by Mr. H. G. Paddock, and read by the Secretary. The nominations were as follows:

President—D. H. Maury.
Vice-President—J. G. Melluish.
Trustees—J. W. Alvord and F. Oswald.

No other nominations being made, it was moved that the Secretary cast the ballot of the Society for the officers named. Mr. D. W. Mead, however, held that an individual ballot of the members was required under the Constitution, and that the Constitution had been drawn up with this in view. It was then suggested that a ballot be taken, but as only one set of officers was nominated, the President stated that he could not see that this was necessary. On motion of Mr. E. Main, it was voted that the Secretary be instructed to cast the ballot (the President ruling that the Constitution permits of this action), and the above officers were declared elected. In regard to this point the Constitution provides as follows:

> Article IV. Section 2. All officers except the Executive Secretary-Treasurer shall be elected annually by ballot by the members, on the second day of the annual meeting.

For the place of meeting in 1906, three nominations were made, Rockford, Peoria and Monmouth; the two latter were afterwards withdrawn, and Rockford was selected by a unanimous vote.

On motion of Mr. H. G. Paddock, it was voted that the Society request the Trustees to hold a meeting at least ninety days before the annual meeting, to assist in preparing the program, inviting persons to prepare papers, etc. The committee appointed to consider the advisability of holding more than one meeting each year reported that four members of the committee thought that such action would be inadvisable, but Mr. J. A. Harman said that while concurring in the report, his own opinion still was that the Society should seriously consider the matter. The report was adopted.

The Secretary read a communication from Mr. George F. Wightman, one of the older members of the Society, expressing a wish to retire on account of age and retirement from business. Mr. J. A. Harman moved that Mr. Wightman be elected an honorary member, and this was carried by a rising vote.

The meeting then adjourned.

JANUARY 20. MORNING SESSION.

The meeting was called to order by the President at 9:45 A. M. Mr. D. H. Maury read a paper on "The New Well and Hydraulic Pumping Plant at Peoria, Ill.," and Mr. W. B. Ewing followed with one on "The Sewerage and Drainage of Wheaton, Ill." Mr. W. S. Shields presented the report of the Committee on Sewers, and Mr. D. H. Maury presented that of the Committee on Water Works. The President appointed Mr. D. H. Maury and Mr. A. L. Waterbury as a Committee on Resolutions.

JANUARY 20. AFTERNOON SESSION.

The meeting was called to order by the President at 2 P. M. A paper on "The Sheridan Road," by Mr. W. S. Shields, was read by title, and Mr. O. L. Gearhart presented the report of the Committee on Roads and Pavements. Mr. R. D. Gregg read a paper on "The Washington Avenue Bridge at Kankakee," and Mr. T. L. Condron gave a talk on "Reinforced Concrete Structures," illustrated by stereopticon views of a great variety of structures. Mr. Frank W. Ives read a paper on "Highway Bridges and Culverts," and Prof. F. G. Frink read another on "The Queen Post Truss." A paper on "Grade Crossings," by Mr. F. G. Ewald, was read by title, as was the report of the Committee on Mechanical and Electrical Engineering. Mr. L. K. Sherman presented the report of the Committee on Structural Engineering. Mr. D. H. Maury announced that the Executive Committee had re-elected Mr. E. E. R. Tratman as Secretary and Treasurer, with a salary of $200, for the ensuing year. After a few closing remarks by the retiring President, Mr. J. W. Alvord, and the incoming President, Mr. D. H. Maury, the convention finally adjourned.

JANUARY 20. BANQUET AND ENTERTAINMENT.

At 6 P. M. about 75 members and invited guests sat down to a dinner, the courses of which were interspersed with speeches and stories. After the dinner the party went in a body to the Chicago Opera House and enjoyed a pleasant evening. The dinner and entertainment were provided by the Chicago members and the Local Committee.

RESOLUTIONS.

At the dinner, the Committee on Resolutions presented the following resolutions, which were unanimously adopted:

Resolved, That the Society extends its thanks to the Illinois Telephone Construction Co., and to Mr. George W. Jackson, the Chief Engineer and General Manager, for their courtesy in providing an interesting trip through a portion of the tunnel system for telephone cables and freight transportation.

Resolved, That the Society extend its thanks to the Cement Department of the Illinois Steel Co., for its courtesy in providing for a visit to the company's new Portland cement plant at Buffington.

Resolved, That the Society appreciates the burden which the Chicago members of the Society have taken upon themselves in connection with this meeting, and that a vote of thanks be tendered to them for the dinner and entertainment provided by them.

REPORT OF THE EXECUTIVE COMMITTEE.

The Executive Committee respectfully reports that it has examined the books and accounts of the Secretary-Treasurer and finds them to be in accordance with the statement in his annual report. The Society had a cash balance of $287.08 in the Gary-Wheaton Bank on Jan. 17, 1905, with no debts. At the time of auditing the books last year, the Society had a balance of $206.34, while this year we have, through the economies, good management, and better collection of dues, increased this by over $80. This has been done in spite of publishing a larger volume of Proceedings, and in spite of a very small increase in membership during 1904.

At this meeting a large number of new members have been elected and the Committee wishes to thank the members for their interest thus shown in increasing the membership. It would emphasize the need of individual effort in obtaining new members, and would suggest that in the coming year each member should consider if there is not someone in his city, township or county, or among his acquaintanceship who ought to be on the roll of the Society. Remember that this Society is a mutual organization, so that we benefit ourselves as well as others by bringing in new members.

The Executive Committee, disregarding the wishes of our modest Secretary-Treasurer, most heartily thanks him for his efficient services and commends him to the Society for its vote of special praise.

THE EXECUTIVE COMMITTEE.

ANNUAL REPORT OF THE SECRETARY-TREASURER.

I have pleasure in reporting a successful year for the Society, and a satisfactory state of affairs as to finances. The books have been submitted to the Executive Committee, and a summary of the receipts and expenditures is as follows:

Receipts—	
Balance in bank, Dec. 31, 1903	$152.68
Annual dues	366.00
Entrance fees	60.00
Annual reports	24.85
Advertisements	457.22
Total	$1,060.75
Expenses—	
Printing and distributing Proceedings	$410.67
Printing bill heads, circulars, notices, etc	41.10
Expenses of incorporation	21.15
Stamps, express and freight	136.91
Stenographer, Champaign meeting	75.00
Convention badges	15.00
Secretary	150.00
Miscellaneous	20.59
Total	$870.42
Balance in bank, Dec. 31, 1904	$190.33
Balance in bank, Jan. 18, 1905	$287.08
Balance in bank, Jan. 20, 1904	$206.34

The Constitution provides that the dues are payable in advance, but many of them are actually not paid until late in the year, and after three or four bills and notices have been sent. On Dec. 31, 1903, there were 29 members in arrears, and on Dec. 31, 1904, this number had increased to 35; and 25 of the latter were in arrears for two years. According to the Constitution, members who are one year in arrears should be dropped from the rolls. This has not been strictly followed, but it has been voted by the Executive Board that the members who are now two years in arrears and from whom nothing has been heard during that time should now be dropped, after due notice has been given them. As these have not replied or paid any attention to bills, notices and personal letters sent to them at intervals during the past two years, it is not known whether they are living, are still in business, or are resident at the addresses on our books. As they show no interest in the Society it does not seem right that the Society should burden itself with a dead-head list, which only increases the expenditures without giving any return.

I regret to report the death of Mr. Orson Dolph, of Yorkville, Surveyor of Kendall County; he died August 30, 1904, at the age of 78 years. Also the deaths of Mr. E. A. Graves, of Streator; and Mr. Noah Whitley, of Joliet.

Since the last meeting two new members have been elected: Mr. Will Dowell, Engineer and Surveyor, of Coffeyburg, Mo.; and Mr. F. W. Van Oven, of Aurora.

At the end of 1904 the Society had 131 members (exclusive of three honorary members). A large number of applications for membership are in hand, to be acted upon at this meeting.

In accordance with the resolution adopted at the last meeting, the Executive Board looked into the question of incorporating the Society. It was decided that this should be done, and after the necessary legal steps the certificate of incorporation was issued by the Secretary of State at Springfield on April 5, 1904. The Society is incorporated as the Illinois Society of Engineers and Surveyors, a corporation not for profit, but with the objects set forth in Article 2 of the Society's Constitution. The only future formalities are the making of annual reports of the election of officers, on blanks provided for this purpose.

There have been 1,600 copies printed of the Proceedings of 1904. The Proceedings were sent to all members and advertisers, to the fellow societies with which exchanges have been arranged, and to the following libraries:

American Society of Civil Engineers	New York, N. Y.
Western Society of Engineers	Chicago, Ill.
American Waterworks Association	Elmira, N. Y.
U. S. Geological Survey	Washington, D. C.
Railroad Commission of Illinois	Springfield, Ill.
Chicago "Tribune"	Chicago, Ill.
Illinois State Library	Springfield, Ill.
Chicago Public Library	Chicago, Ill.
New York Public Library	New York, N. Y.
John Crerar Library	Chicago, Ill.
Library of Congress	Washington, D. C.
Library of University of Chicago	Chicago, Ill.
Library of University of Illinois	Champaign, Ill.
Library of University of Wisconsin	Madison, Wis.
Library of University of Michigan	Ann Arbor, Mich.
Library of Purdue University	Lafayette, Ind.
Library of Cornell University	Ithaca, N. Y.
Library of Washington University	St. Louis, Mo.
Library of James Milliken University	Decatur, Ill.
Library of Norwich University	Northfield, Vt.

The societies with which exchanges were made are noted below. This year it is hoped to add to the list the Ohio Society of Civil Engineers and Surveyors, which society has published no reports for two years, but now seems to be taking a new lease of life.

Connecticut Society of Civil Engineers.
Michigan Engineering Society.
Indiana Engineering Society.
Iowa Engineering Society.
Engineering Association of the South.
Memphis Engineering Society.
Purdue Society of Civil Engineers.
"Technograph," University of Illinois.
"Technic," University of Michigan.
Association of Ontario Land Surveyors.

The character of our Proceedings has been well maintained, and we have a good list of advertisers.

During the year there has been considerable correspondence, and the business of the Society has been given proper attention.

In conclusion it is hoped that members will continue to show a practical and active interest in the Society and its affairs, and so help to maintain its present flourishing condition. The officers do their utmost in this direction, but the members must also do their share of the work in order to support the reputation of the Society.

E. E. R. Tratman,
Secretary and Treasurer.

List of Members Elected at the Annual Meeting and up to May, 1905:

A. B. Alexander,
A. E. Barber,
H. Bloompot,
W. P. Bushnell,
T. S. Byrne,
H. L. Canman,
R. A. Carpenter,
T. L. Condron,
H. L. Emerson,
P. E. Fletcher,
F. G. Frink,
J. G. Gabelman,
Leo. Gluck,
J. G. Graff,
J. B. Hittell,
F. W. Honens,
G. C. Habermeyer,
E. M. Hagar,
F. W. Ives,
C. C. Jacobs,
W. H. Kimball,
W. G. Kirchoffer,
F. C. Lang,
Wm. Lee,
F. W. Lucke,
E. Main,
W. W. Marr,
C. C. Martin,
C. Mendius,
M. R. Miller,
J. A. Moore,
A. E. Nelson,
T. F. Quilty,
C. N. Roberts,
V. B. Roberts,
J. H. Sabin,
W. Seafert,
E. F. Seelig,
W. A. Shaw,
G. B. Sidelinger,
A. D. Waterbury,
A. L. Webster,
C. P. Westerfield,
R. E. Williams,
W. M. Wood,

PRESIDENT'S ANNUAL ADDRESS.

BY JOHN W. ALVORD.

It is my duty and pleasure to call your attention to some of the things which this Society has acomplished in the past two decades, and to its peculiar field and functions at the present time, and to the hopes for its future.

OUR HISTORY. The Illinois Society of Engineers and Surveyors held its first meeting at Champaign, Feb. 23, 1886, with 40 members present, and a number of valuable papers were read. This meeting was the outcome of efforts of our honored first president, Prof. I. O. Baker, who having observed the success attending the meetings of the state societies of Ohio, Michigan and Indiana, sent out letters to personal friends and upon receiving favorable answers formulated a program and issued a call for the first meeting. Mr. Hodgman, of the Michigan society, and Mr. Fred J. Sager, of the Ohio society, were specially invited and attended this meeting. Prof. A. N. Talbot was elected our first Secretary and formulated our constitution and by-laws.

The second annual convention was held at Champaign in 1887, with a net increase of 7 members and our time-honored precedent of giving a good President a second term was inaugurated by the re-election of President Baker. At this meeting, Mr. S. S. Greeley introduced the subject of a surveyor's license. We are still agitating for its enactment, and will continue to do so until the necessary legislation has been secured. At the annual meeting in Springfield in 1888 the membership jumped to 76, and Mr. C. G. Elliot was made President. From this time on the growth of the Society was gradual and steady. Prof. Talbot served as President for two years, with the conventions at Peoria and Springfield. And in 1892, when the first Chicago meeting was held (at which Mr. S. S. Greeley was made President), our numbers reached 113, a high water mark which was not again attained for nearly ten years. The hard times of 1893 to 1896 were a severe blow to the engineering interests of the state, and not only did our membership fall off to a low water mark of 60 in 1895, but the Society was for some years in debt and was obliged to practice strict economy. The value of our professional papers increased, however, and the discussions and committee work were of great interest, thus much more than offsetting the loss of membership and loss of revenue.

Mr. Daniel W. Mead, of Rockford, succeeded Mr. Greeley as President in 1894 and the two conventions under his leadership were held at Champaign and Monmouth. Brick paving became of general interest to the members of the Society about this time and a number of conventions were exceedingly valuable and profitable to those interested in this question. The presidency of Mr. Stowell in 1896 marked a period of recovery from the financial stringency of the preceding years, and the membership began to increase slowly but surely to about 86 members in 1897 at Peoria. Mr. Jacob A. Harman succeeded Mr. S. A. Bullard as Secretary in 1895.

In 1898, Mr. A. D. Thompson, of Peoria, became President, and conventions were held at Bloomington (1898) and Champaign (1899). The latter city indeed holds the convention record, having been visited five times by our Society; Springfield following with four conventions, and Bloomington with three. Twice we have been at Peoria and Chicago, and once each at Monmouth, Moline, Joliet, Aurora and Elgin. With Mr. C. C. Brown, of Bloomington, as President, conventions were held at Moline (1900) and Bloomington (1901). The hospitality of Bloomington indeed could not be overclouded by its recent disastrous fire, and at least three members of the Society will never forget the charming hospitality of the county jail in the absence of more usual accommodations. The Joliet and Aurora meetings (1902 and 1903), under the presidency of Mr. Henry Paddock, of Moline, saw the membership increase to 116 and 123, respectively. But engineers were busy again and both attendance and interesting papers were less numerous than in "hard times." The Champaign meeting of 1904 had a good attendance and its program was full to overflowing with valuable papers. Mr. M. S. Ketchum succeeded Mr. Harman as Secretary in 1901. Mr. E. E. R. Tratman became Secretary in 1903, and is still with us.

In the production of professional papers of merit our Society takes high rank. Most of our best papers have been reprinted in the technical journals. Through the exchanges with several other state and technical societies they circulate among 1,500 to 1,800 engineers scattered in all parts of the country and are highly prized. Surely this is no mean audience and one which it is well to keep in mind when we write. Some 366 papers and committee reports have been presented to the Society in the 20 years of its existence. Of these papers 64 are upon surveying and allied subjects, 43 upon water supply, 41 on railways, 38 on drainage, 34 on highways, 26 upon street pavements, 21 on bridges, 19 upon sewerage, 13 upon sewage disposal, 11 on cement and concrete, 8 on mining subjects, 8 on general sanitation, 7 on municipal topics, 5 each on electrical engineering and geological survey.

It is curious to observe that the subject of race tracks and engineering ethics run each other neck and neck with four papers each. Parks are credited with three papers, and there are two each upon tunnels, public works and steel structures; also one each upon architecture, electric lighting, astronomy, education, canals and aerial navigation. Truly this is a formidable array and makes 20 pamphlets of much interest. Together with our exchanges they form a small library by themselves.

OUR FIELD AND FUNCTION. With this brief account of the past, your President cannot but pause to ask what is the function of a State society? Why does it exist and what is its especial work? The first thought of one well acquainted with the engineering profession and its status is that we have too many societies already and that a multiplication of societies is unfortunate. One strong society should be sufficient. I answer to this that such an argument would be valid were there in this country one society broad enough in its scope, elastic in its grading, and affording opportunity for local chapters, with local interest, and with a missionary spirit rather than an exclusive attitude. No such society exists, therefore we find the demand for affiliation among our professions, especially local affiilation, takes the form of the small independent society with a distinct clientage and territory.

In the larger cities it is possible to form such societies of considerable strength and influence, which while giving a localized center for men of the highest rank, also gathers to itself men doing engineering work who are not reached by the national societies. This is partly because of the exclusive attitude of the national societies, partly because of the lack of broader professional feeling among such men, and partly because the national societies do not furnish a local center of interest. Now, what such societies do in the larger cities, the State society finds increasingly desirable to do in the smaller cities and generally throughout the state. Here we meet the isolated engineer doing his work under increased difficulties, without opportunity for exchange of experience, without professional sympathy and good will, and even in some instances without much appreciation of the fact that he belongs to a profession at all. So little is he brought into touch with the sense of brotherhood which ought to be and increasingly is a feature of the profession.

The state society therefore stands on the firing line and its function is first of all to convince the isolated engineer serving perhaps an unappreciative public in the smaller communities that he is a member of a profession, to bring him into line and convince him that organization is an obsolute prerequisite to all professional progress, to destroy his distrust of his fellow craftsman and show him that there are some things in life which are not sordid. To teach him to give out as well as absorb information, to enable him to discover that in doing so he will receive in return a hundredfold of what he is able to give. To help him to do his work better and to take pride in it. To so cause him to grow in his profession that by and by he will join some of the larger societies and give them his support and assistance.

This then is one of the greatest aims of the state society, and this was in the minds of its founders; this has been always its object amid many discouragements, and this is the cause of the devotion of so many men of age and standing in such societies. We find many men drop out of our Society. Sometimes they go into the larger societies. Sometimes they leave because they lose interest in the profession. Sometimes they are disappointed with it because they joined it from selfish reasons. Removal to other states, change of business, misfortune and death are always working mischief with our membership roll, but our gains are steadily larger than our losses, and the field is always widening; slowly but surely we are covering the ground. Should a national society of wide scope be formed with local chapters, our work and functions would be merged in it, and our peculiar formation would cease to have any significance. But until then, we have a work to perform, which though in some respects arduous, has been peculiarly gratifying to all engaged in it, for it does not take an unusually keen eye to note the change which has passed over engineering in the State of Illinois in the last 20 years. Our State University has of course been the most powerful influence, but the growing appreciation of technical education, the value of scientific investigation, especially in municipal work, has been remarkable. So that today it can be said that engineering as a profession is understood and appreciated as never before in Illinois.

FUTURE OF THE SOCIETY. For the future it can only be noted that with this meeting the Society will in all probability pass the 150 mark in its membership. There are probably twice as many men as this in the state who would appreciate its work and enjoy its membership, if they could be awakened to the fact that they belong to a profession and catch the spirit of brotherhood and helpfulness that pervades our meetings and discussions. The work therefore of the Society is not at its highest level until a goodly majority of them are brought in. We need the water works superintendents. We should have more of the surveyors, all of the city engineers, most of the growing railway engineers, more chemists, biologists and health officers. And with increasing membership we shall hope for increasing influence for the good of the profession. We note hopefully the stirring message of our new governor in the direction of good roads and a state geological survey and we should throw our influence for these as strongly as we know how. The surveyors' licensing bill should be passed, and we must make another effort in this direction.

In closing this 20th annual message, I cannot but congratulate this Society upon the spirit of friendliness which has always pervaded its meetings. We have met always as a brotherhood to talk over our work and give and get light, and no serious bitterness or jealousy has ever marred our deliberations in all these 20 years we have been together. Let us take that thought as an augury for the future and hope that always we shall go on in the same friendly spirit, giving and getting light.

HISTORY OF SURVEYING IN CHICAGO.

BY S. S. GREELEY (HONORARY MEMBER).

Landing in Chicago early in October, 1853, I had some six months of desultory work as clerk, and then carried out a long-cherished plan of settling somewhere as a local surveyor. I joined an old surveyor, and formed the firm of Hanchet & Greeley, surveyors and civil engineers. My partner was familiar with the U. S. plats and field notes, and with western methods of survey. I knew nothing of these, but furnished a transit, level, rod and a limited knowledge of mathematics. The transit had not then displaced the old-fashioned sight compass, which was still used in surveying. I think my transit was the first put to that use here. The new firm made surveys for new buildings, and laid out numerous subdivisions in the city and the adjacent territory.

In those days measurements were made with the chain, made of iron links and rings, which lengthened with the opening of the joints, and shortened with the mud and dust which caught between the parts. Sometimes in earlier days chaining was done with a clothes line, if we may trust the sworn evidence of Mr. George W. Snow, a surveyor of credit and renown, who flourished in the '40s. The great discrepancies between the dimensions on the recorded plats and the monuments on the ground amply justified Mr. Snow's statement. Even the clothes line as an instrument of precision ranks a little above Abraham Lincoln's historic grape vine.

In the State constitutions of 1818 and 1848 no mention was made of the county surveyorship, which was purely a legislative office till 1870, when the new constitution named it in its list of county officers. By a constitutional amendment adopted Nov. 22, 1880, the surveyorship was omitted, and it became again a legislative office. Before 1874 the statutes required that all plats of towns or additions thereto, and of subdivisions, should be made and certified by the county surveyor, or by the city surveyor if within a city having such an office. This created a virtual monopoly in the most lucrative part of the surveyor's business. As in populous counties, like Cook, there was more work than the official man could do; he usually certified the plats of the private surveyor, charging a fee of about 10% of the value of the work.

The charter of the city of Chicago, granted in 1863, abolished the city surveyorship, and provided for the licensing by the Board of Public Works of surveyors, who should present evidence of competence, and should give bonds in the sum of $2,500 for the faithful discharge of their duties. In 1867 the functions of the licensed surveyors were extended to the county of Cook. In the revision of the statutes in 1874, it was provided that an owner wishing to subdivide his land should employ the county surveyors "or some other competent surveyor" to survey and plat the same. Thus by the slow process of legislation, an ancient monopoly was finally eliminated, and opportunity was opened to ability.

About 1865 a few surveyors in Cook and Sangamon counties met at Springfield to consult upon matters of common interest. The practical monopoly then held by the elected county surveyor was felt to be an injustice to the private surveyor, and a burden upon the farmer and the land owner. Under the sanction of this meeting of surveyors a bill was drawn for the licensing by the State, of surveyors of approved ability and good character, who should perform all the functions of the county surveyor, throughout the State. The bill was presented at the next session of the legislature and was favorably reported by the committee, but failed to pass for want of time. Since that time, bills of like tenure have been introduced at some five or six different sessions. Sometimes such a bill has passed in one house and failed in the other; again it has failed in both houses. The county surveyors throughout the State joined in opposing the bill, or held aloof, feeling, with some reason, that the bill bore upon its face a suggestion of the uselessness of their office, and was perhaps a step towards its abolition.

This movement for the licensing of State surveyors was mainly confined to the profession in Chicago; little interest in it was shown in other parts of the State. The attempts made here within the last few years to formulate a bill to this end have been defeated by the great diversity of opinion among its advocates, as to what its provisions should be. The bill finally drawn proved so complex, and so overloaded with details as to be unworkable. For myself, I have come to the opinion that the present law is liberal enough, and that it is wise to let well enough alone. Probably there are counties where the office of county surveyor is and always would be a public convenience. In any future legislation on the subject this office should be made appointive and not elective; and it should be left optional with the county board of each county whether to appoint a surveyor, or to leave the place vacant.

A question always of vital interest to the surveyor is how far he may be held liable in damages for errors in judgment or faulty work, or for difference of opinion with other surveyors as to the location of boundaries. The only case wherein this question has been submitted to the courts for judicial decision, so far as I know, was in the year 1856. William Clogher, then City Surveyor of Chicago, was sued for the mislocation of a building to be erected at the S. W. corner of State and 12th Sts. The building, which had reached the second story, was adjudged to be encroaching some 2 ft. upon 12th St. It was taken down, and damages found against the surveyor in about $600. No appeal was taken, and the case was settled. Since that time in several cases damages have been paid by surveyors, without contest, for palpable and admitted errors.

The proprietor, whose lines are in doubt, sometimes says in effect to his surveyor: "You claim to be a mathematician; mathematics is an exact science; surveying is a mathematical operation. You should be able to locate the bounds of a given tract with unerring certainty, and two or more men of equal skill ought to agree precisely." To whom the surveyor may reasonably make answer: "Your boundaries, like all other boundaries in Illinois, rest primarily upon section corners marked by posts and mounds established by U. S. deputy surveyors nearly 100 years ago—say between 1821 and 1835—and secondarily upon stakes said to have been driven by county and other surveyors at various remote periods, to represent the corners of lots, blocks and streets in the subdivision of original quarter sections, and parts thereof. These original posts and mounds were, from their size and nature, somewhat vague and indefinite monuments, from which to fix the limits of lots worth $5,000 to $10,000 a front foot, or $600 an inch. They were raised in the virgin soil, untrodden except by the foot of the Indian hunter, and were often disturbed or obliterated by the forces of nature and by the trampling of the buffalo herds. The subdivision stakes were for the most part driven in the still green and unbroken prairie. Since those times a city of two million people has sprung into being its improvements have long since swept away every trace of the original land marks. It is safe to say that within the limits of Chicago, perhaps within the county of Cook, there exists today not a single U. S. monument, nor an authentic stake of the numerous Canal Trustees' subdivision. Of all these monuments, which were of prime and undisputed authority, while they remained undisturbed, we have only secondary or traditional and imperfect knowledge. During this long interval of 50 to 80 years surveys have been made, fences and buildings erected, streets laid out and improved. We assume that the unknown artificers worked to the ancient landmarks, but there is, or soon will be, no living witness to testify to this. How then establish any relation between the ancient landmark and the later structure?"

The surveyor is for the moment a judge. His bench is the curbstone or the stump; his witnesses the stakes, stones, fences, and buildings and such other evidences of possessory rights as he may find. Frequently the testimony of these mute witnesses is in conflict with itself and in dire disaccord with the facts as stated in deeds and recorded plats. One surveyor bases his opinion upon one set of objects, which seem to him conclusive; another man of equal skill has depended upon another and conflicting set of objects, apparently of equal validity. Hence come disputes over land lines, and possible liability of the surveyor for error in judgment. If sued he will probably make successful defence; but at law victory is often as disastrous as defeat. The vast increase of value of real estate, especially in the business district of this city, has made the determination of boundaries a much more minute and responsible work than it used to be. A man who will lay out with a light heart a lot valued at $100 a front foot, will lie awake at night thinking of the survey he has just made of a lot, which has been bought for $8,000 a foot, for a structure which is to cost $1,000,000. Recurring to the previous question, I say land surveying as usually practiced is not a precise or exact operation. Geodesy, the measurement of portions of the earth's surface, may be done with reasonable accuracy, limited by the defects of instruments, and by the infirmity of human faculties. Land surveying is only an attempt to apply the methematical and physical processes to the solution of problems, the conditions of which are necessarily indeterminate. No man can say that he has found and marked the true lines of a lot as they were originally marked sixty years ago; at the best he has only laid down lines which will probably never be proved wrong. The security of the owner, once in possession, lies in the inability of anybody to bring better evidence in favor of another location.

One prolific source of discrepancy in surveys lies in the lack of a public standard of length for the verification of the steel tapes and other measuring instruments of the surveyors. A section still in force of the Revised Statutes of 1845 makes the county clerk of each county the sealer of weights and measures for his county, and requires him to procure at the expense of the county, "when authorized by the county board," a full set of weights and measures, scales and beams, which he shall cause to be tried and proved and sealed by the state standards, under the direction of the Secretary of State. But there is nothing requiring the county board to act in the matter, and the County Board of Cook County has never taken such action. Probably the same is true in other counties. There is a city officer known as the inspector of weights and measures; he compares and seals scales and weights, and measures of capacity, but he considers it no part of his duty to inspect measures of length, and he has no standard of length.

When I began practice in Chicago the city sealer had a somewhat battered brass bar, which he kept on a shelf in his place of business, and which was known as the standard yard. No man knew whence it came nor what was its authority, and I think it was rarely, if ever, used for comparison. About 1866, at the instance of some surveyors, the Board of Public Works procured from the U. S. authorities at Washington two steel yard bars with proper certificates. These were used by end contact for laying down 50-ft. floor standards. They were lost in the fire of 1871. Shortly after the fire, Alexander Wolcot, then county surveyor, got from a friend in Washington two standardized 6-ft. steel bars, which were used by him and by other surveyors in laying down floor standards. These bars are now in possession of Mr. F. C. Rossiter of this city. About 1885, the Western Society of Engineers procured from the Coast Survey office at Washington two bars for end contact, of 4-ft. and 6-ft. length, with certificate as to temperature at which they were standard, and as to variation for change of temperature. These bars with their wooden case disappeared many years ago—probably stolen from the office in which they were kept; they have never been recovered. The Society has laid down a 100-ft. standard on the floor of the Monadnock Building. One surveying company procured from Washington some ten years ago two standard steel tapes for their own use. Probably other offices have done the same thing. These several standards are probably available to any one desiring to use them for comparison; but none of them has ever been officially adopted by the municipal authorities, and they are in no sense legal public standards such as the law contemplates. There is not today, and there never has been, in the city of Chicago, nor in the county of Cook, a legal and authoritative standard of length for the verification of measuring instruments. No surveyor can testify on the witness stand that his measurements are correct; he can only say that he has used such means of comparison as were within his reach. The comparison at Washington can always be made. Prof. Stratton, Director of the Bureau of Standards, is always ready to compare any measuring instrument which may be sent to him, with the U. S. standards, charging only the actual cost of doing the work. I have gone thus at length into the history of standards here because it seems to me of great importance that every county in the State should have a public standard of its own, accessible to all under proper supervision. In no other way can uniformity of work among surveyors and engineers be secured.

At a meeting of the Western Society of Engineers held April 2, 1902, it was resolved that a committee of five be appointed by the President "to study the subject of mural or bench standards of length, to determine the proper shape, size, location and marking of such standard for this county and city, and to see how and where they may be best procured, and how they may be safely transported from the place of manufacture to their final site." "Resolved that this committee make its recommendations to the proper officers of the county and of the city, and they use the influence of this society to cause the instalment of the standards by the public authorities as promptly as possible." John Ericson, Geo. H. Bremner, A. C. Schrader, T. L. Condron and Peter Heer were named as the committee.

The committee seem to have been active during this interval of three years. They have prepared plans and specifications for the work and made an approximate estimate of the cost. The standard is to be a continuous bar of merchant steel, 100 ft. long, 4 in. wide and ½ in. thick, lying upon thin brass strips over a plank platform, and supported by brass rollers to allow longitudinal motion caused by expansion. The structure is to be supported by cement columns, frost proof. The bar is to be brought from the place of manufacture and placed in site without bending. It is to be placed on flat cars, so supported as to allow lateral motion on curves; and it must be carried to the train and thence to its final position on the shoulders of men without being bent. The estimated cost is $300 to $500. After being fastened into place it is to be calibrated by an expert and his assistant, detailed for the work by Prof. S. W. Stratton, Director of the Bureau of Standards at Washington, D. C. After much correspondence and personal application the committee are still unable to find a site for the structure. The following letter, dated Jan. 10, 1905, from Mr. Ericson, City Engineer and chairman of the committee, gives the present state of affairs:

> Replying to yours of Jan. 9, I wish to state that the committee appointed by the Western Society of Engineers to arrange for the installation of a mural standard bench in the city of Chicago worked for a long time with a view of having said standard bench installed in the new Government Building. The promises made by the architect and other officials of the Government were such as to make it almost a certainty that we would be allotted space in said building. After waiting many months we were finally informed that no space could be given for this purpose, and the committee had to commence the work of securing space all over again. A sub-committee was then appointed to ascertain whether space could be obtained either in the new La Salle St. Station or at the Field Museum. Even in this we failed. I then addressed a letter to the Chicago Library Board, requesting permission to place our standard bench in the vacant space west of the Library Building. After another long wait I have just been informed that we cannot obtain this space. I have now arranged with Mr. Schraeder of the committee and with Mr. Foster of the South Park Board for a meeting at my office when an attempt will be made to secure space somewhere on the lake front. In the meantime, plans have been prepared for the bench, and as soon as space has been secured I shall attempt to have an appropriation made for defraying the expenses of the same.

Some 33 years ago the surveyors of Chicago passed through a unique experience, which, it is hoped, may never be repeated, either here or elsewhere. It was the restoring of lost corners and the marking of lines for the rebuilding of the city, a large part whereof had been destroyed by the great fire of Oct. 9 and 10, 1871. Some years after this disaster a number of persons who had been eye witnesses of it were asked to write some account of their personal experience. Perhaps a few lines from one of these accounts will give some idea of the work of the surveyors and its conditions.

> It soon became evident that a task of great magnitude and delicacy had fallen upon the surveyors of Chicago. The boundary lines of thousands of lots in the burned district must be retraced for re-occupation and building; and this must be done in streets still hot and smoking, and that would burn and smoke for months. Land marks were destroyed or covered by fallen ruins; and, worse than all, the recorded plats, maps and deeds of property in the city and county were burned. This work could be done only by men of long experience in surveying in and about Chicago, familiar with the plats and with the physical conditions. In looking back after this long interval I recall with wonder the ease and rapidity with which the people adapted themselves to the changed conditions in commerce, in domestic affairs and in social relations. The eleventh of October saw a city without a bank, a hotel, an office building, a theatre, a wholesale store or post office, with many of its principal churches destroyed and 30,000 homes in ruins. The dwelling houses and other buildings skirting the burnt district on the West and South were rented at large prices, and hastily converted to business uses, and great wooden barracks for temporary use were rapidly thrown up, by special permission of the city government, on the park property along the lake shore. These were soon tenanted by banks and stores.
>
> Within 15 days after the fire I had established my surveying office in the kitchen and laundry of a fashionable brick residence on Wabash Ave.

near Harrison St. The cooking range and laundry tubs were made to serve as stands for drawing boards and desks; the drawers, shelves and cupboards held field-books, plats and maps; the spice boxes were convenient places for pencils, stamps, envelopes and other small stores; and some stray sad irons made excellent paper weights. Happily copies of many or all of the recorded plats had been saved by removal from the offices of the abstract firms in the night of the fire. Some days later other copies were found unharmed in the fireproof vaults of two real estate firms, Ogden, Sheldon & Co., and Rees, Pierce & Co. These copies were of vast use, indeed they were an absolute necessity in restoring boundaries and in protecting titles. Without them there would have been chaos in land ownership. The city government promptly and very wisely bought of the two firms the right to copy their atlases and maps for public use, and the surveyors had free access to them for their professional work. Coal piles, merchandise and timbers filled the basements, still smoking or smouldering, and forbidding all approach. The roadways and sidewalks were obstructed by heaps of hot bricks and stones from the fallen walls. The engine house of the city water works had been burned and the engines disabled. The engines and pumps were repaired as speedily as possible, but it took two or three weeks to put them in order. As soon as this was done and circulation re-established, fire engines were kept at work throwing water on the ruins so that men and teams could work in clearing the debris. The eyes of the laborers and surveyors suffered greatly from dust and ashes, unless protected by goggles.

There were four or five surveying offices in the city, and the men all worked with a will, helping each other with notes and personal recollections as to boundary lines and monuments, and in many other ways. Professional rivalry was sunk, and every man seemed ready to do his best to help restore the city. With land marks obliterated and records destroyed there was much room for honest difference of opinion among surveyors and for contention between land owners. But such questions of boundary as arose were settled by conference, and there was surprisingly little controversy. I do not now remember a single case of litigation over questions of this sort.

MODERN SURVEYING IN CHICAGO.

BY S. N. HOWARD (MEMBER).

City surveys are made: First, to establish monuments, corners, lines and boundaries, and thus divide land into blocks and lots. Second, to identify and locate such monuments, corners, lines and boundaries after they have been established, and to replace them where they have been destroyed. The first class of surveys forms a very small portion of the practice of the Chicago surveyor of today. Subdivisions are, as a rule, well made; much better than the older subdivisions, owing to the better appliances for measurement, the steel tape being universally used for this purpose.

The surveyor who makes surveys in down-town Chicago finds much difficulty owing to the crowded condition of the streets, the piling of goods on the sidewalks, projecting doors and show-windows, etc., the only possibility or doing the work, in many cases, being early in the morning before the crowd gets out, or else on Sunday. It has been more than hinted that two surveyors could not agree on the lines of a lot. While this is far from being true, we do sometimes have differences, the only wonder being that there are not many more when we consider the conditions under which surveys have to be made in a great and growing city.

The placing of public improvements, street pavements, sewers, and the network of pipes which underlie our streets, has destroyed every section corner monument in Chicago, except possibly a very few in the outskirts of the city. The stakes marking the lines in the older subdivisions soon rotted away or were replaced by fences or buildings more or less accurately placed on the line, and these probably several times renewed. The conditions being such, the only thing left for the surveyor to do is to depend on occupation. He accordingly runs the lines of the streets bounding the block in which he is to operate, by such buildings or marks as he may have noted in former surveys or such as may appeal to his judgment. If he runs the line for any considerable distance he will undoubtedly find that some of the buildings, and marks of other surveyors (and possibly some of his own) are not in line.

In establishing interior lines, the rule of course is to divide the actual measurement of the block in proportion to the record of the several lots; but in most cases all of the occupation does not agree with the proportion, possibly only a small portion of it. In this case, the surveyor places the line where, in his judgment, it will best harmonize with the general occupation, work the least injury to all parties concerned, or will be upheld by the courts, should the case reach them. Occupation, therefore, cuts a large figure in city surveying, and if long enough continued establishes that particular line without question. Even in cases where the surveyor may have evidence that lines were established in a way differing from the bulk of the occupation, it may be better to acquiesce in the erroneous location and thus prevent the plunging of neighborhoods into quarrels and litigation. This view, however, does not meet the approbation of some of our legal friends or of some owners who seem to be anxious to get into a "scrap" with their neighbors.

The buildings erected in the down-town district after the fire of 1871 were generally of an ornate style of architecture, thereby causing uncertainty as to what part of the building was intended to be on the street line. The steel frame skyscrapers of today, while they usually have a plainer front, are frequently set with one corner on the street line or slightly into the street and the other back from the street in order to square up the building so there may still be uncertainty.

In the later subdivisions where there are still original stakes standing or where permanent buildings have been erected in conformity with the original stakes, there is comparatively little trouble. One trouble is that the lines are usually marked or notched in the sidewalks, which being largely of cement, are not stable. The walks move and the marks go with them. The requirements of the architect as to surveys, now, and at the time the writer entered the surveying business in Chicago, upward of 30 years ago, are quite different. Then, besides the lines of the lot, the grade was sometimes wanted, and once in a great while some one would call for the elevation of the sewer, but such a thing as taking the angles of lots was unheard of. Now the usual requirements are lines, grades, angles, location and elevation of sewer, elevation of walks in front of lot and adjoining the same and elevation of ground; and sometimes in addition are the size and location of water, gas and electric mains; the location of point where water, gas and electric service pipes come through the curb; location of house drains; the location, height and plumb of adjoining buildings; thickness of party walls at the several stories and location and depth of the foundations of the same.

Besides the ordinary survey, the surveyor is frequently called upon to establish bench marks on buildings adjoining sites where building operations are in progress, or on buildings with weak foundations which are consequently settling, these observations being repeated at intervals for months or even years. The bench marks of Chicago were in a chaotic state until a few years ago when steps were taken to establish permanent bench monuments, as set forth in the report of the Committee on Surveying last year. Uniformity is now being gradually evolved through the use of these monuments and of intermediate benches made by the grade and bench engineer of the city, which benches are accessible to the surveyor. Street grades are also getting into better shape through the efficient work of Mr. W. H. Hedges, the Grade and Bench Engineer of the Department of

Public Works. An accurate record is kept of the date of all ordinances establishing grades, new grades are being established, and old grades are changed to agree with existing walks whenever differences are brought to the attention of the Department.

One need of the surveyors of Chicago is a public standard of measurement. There are a few private standards in use, but it would be much better if there was one standard accessible to all. In the ordinary lot survey, where the length of the block is divided pro rata, a discrepancy in the length of the tapes is not so material, but in cases where absolute measurements are to be made (as where property is described by metes and bounds), it is absolutely essential that we have a correct measure.

CHICAGO STANDARD BENCH MONUMENTS.

BY W. H. HEDGES,

Bench and Street Grade Engineer, Department of Public Works, Chicago.

In the nineteenth annual report of this Society (1904) the report of the Committee on Surveying included a statement relative to the original establishing of Chicago city datum; the differences in bench marks supposed to refer to that datum, and the annoying and troublesome conditions resulting therefrom about the year 1893. The committee also referred to the report made by me while Assistant Engineer in the Bureau of Sewers, to the Commissioner of Public Works, on the subject of Chicago city datum and city bench marks in 1895, and illustrated the bench monuments then devised and recommended for the preservation and maintenance of the Chicago city datum.

BENCH MONUMENTS—The term "standard bench monuments," may seem a rather large name for these comparatively small blocks of concrete, but the strictly correct name of "standard benches," had already been appropriated for the 18 points established by some of the city engineers, and legalized by action of the City Council in the year 1888. Such variations were soon found in these "Standards" that they ceased to be of value, and it was to avoid confusion with these standards, and possible error in after years, that the larger name was adopted in submitting bench monument elevations for action by the City Council.

In the fall of 1897 the proper city officials ordered the location and construction of 50 "standard bench monuments," such as were recommended in the report of 1895. They are of the best granite concrete formation, 42 ins. square at the base, 16 ins. square at the top, and 6 ft. from bottom to top of concrete. In the center of the top is set a hardened copper rod ½-in. diameter and 2 ft. long. The end of this rod showing in the top of the concrete, is the bench point on which the elevation of the monument is established. An iron cover is set on top of the concrete, having a lid locked by a self-acting weight lock; the top of the cover comes just level with the surface of the ground, or with the street grade.

In 1898 there were 32 more of these monuments built, making 82 in all. They are set about one mile apart, north and south and east and west, being placed as near to the corners of sections as the improvements already on the ground will permit. They are mostly placed in the grass plot between the street curb and the sidewalk, where the ground is entirely under the control of the city, and where the cement walk is extended out to the street curb, the iron cover comes flush in the surface of the walk. The exact location of each monument is carefully noted and recorded. A special council ordinance provides a penalty of from $50 to $200 for "destroying, covering up, or in any way injuring" them.

The levels for determining the elevations of the bench monuments were taken with a Y-level, the different lines being run two or three times, checking from point to point in every direction, with such care and in such a manner as to insure great accuracy. As the precise level system was not used, the term "exact level," has been adopted in speaking of this work. The precise level system was not adopted, as it was fairly demonstrated in running the levels described in the 1895 report on Chicago datum, that with proper care and the use of correct methods, equal accuracy in results could be obtained by the exact Y-level system, and the expense would not be half as great.

The conclusions arrived at in the 1895 report, as to the then correct elevation of the old "Lind Block bench," having been accepted and legalized by action of the city council, the corrected elevation of that bench was taken as the initial or starting point, and from it lines of eact levels were run enclosing a rectangle, whose perimeter lines were approximately along Randolph St., Michigan Ave., 12th St. and Sangamon St. At convenient points on these perimeter lines six bench monuments were established. Then from these monument points on this rectangle, other rectangles were run joining onto the first rectangle on its north, west and south sides. This process was continued, extending the work towards the city limits in every direction. Every line of levels was run at least twice (in the same direction), and sometimes three or four times if any disagreement developed in closing any rectangle. The results have been most satisfactory and well within the limits prescribed for precise levels. It may be remarked in this connection, that it was a very fortunate circumstance for the city, that this work was begun while the Lind Block bench, the last old original bench mark, was still in existence. It has since been destroyed by fire.

In the prosecution of this work, the observance of certain rules or methods was found to be very necessary. The following are some of the methods observed: The instrument should be shaded by an umbrella when taking sights: the level when not in use should be turned so that the sun's rays could not strike the bubble; the sights should not exceed 175 ft. in length, while 150 ft. would give better results. All turning points should be on a point and not on a flat surface; the rodman must stand at the side of his rod instead of behind it, so that he might plumb his rod one way while the instrument plumbed it the other way; all sights should be taken at least three times over, the target being set each time independently, the first two readings of the rod being carefully noted down by the rodman, and the last reading brought up to the engineer to be read by both persons; a variation of over three-thousandths in setting the target in the three sights, making necessary one or more settings of the target, the average rod reading being finally adopted. All the readings to be by the setting of the target to the thousandth.

The exact levels establishing the elevations of the 82 bench monuments built were completed in 1901, covering not quite half of the city territory, and since that time no more monuments have been built, and therefore the exact levels could not be extended. The north and west sides of the city are mostly included in the territory having the advantage of these monuments, while the towns of Lake, Calumet and a large part of Hyde Park are without them. Each year the effort has failed to obtain the money necessary to build more bench monuments and give the Bench Engineer an assistant engineer to attend to the street grade portion of the work, while the Bench Engineer devotes his time to the extension of the monument levels. For this reason no advance in the bench monument work has been made in the last three years, and over half of the city is unprovided for.

ORDINARY BENCH MARKS—In running the lines of levels for establishing the elevation of the bench points in the bench monuments ordinary bench marks were also established along the route, on the best points that could be found for that purpose. On the water tables of brick or stone buildings, stone steps, stone curbs, nails in roots of trees, and even tops of hydrants, where nothing better was available. The elevations of the bench monuments were reported to the City Council, to be legally and officially established by council ordinance. But the ordinary bench marks were not reported for council action and did not become official in character, and the city could not be made liable for any error arising from their use. In the bench books giving the elevation of these ordinary benches, the attention of engineers using them is called to the necessity of checking from any one bench to some other, and in event of any disagreement, that reference should be had to the nearest bench monument. This is necessary because of the settling of brick buildings, changes caused by repairs, or an error from the rod being held on the wrong point.

The limit of closure on the circuits for these bench marks was that established by the European Geodetic Association, or slightly over 0.02 into the square of the distance in miles. The U. S. Survey report of the Secretary of War for 1887 gave a limit on their precise leveling of something over 0.04 into the square root of the distance in miles.

In our ordinary benches on buildings, we frequently find differences because of the settling of the buildings. Where the bench is taken on the steps of a building, sometimes that step is changed. But our bench monuments are built so that the bottom is below the level of the frost, and being in the shape of a frustum of a pyramid, the frost cannot lay hold of it to move it. While the bench monuments are subjected to very close comparison in every direction, I have heard of but one, where the claim is made that it has varied 0.02 or 0.03, and that one is on Michigan Ave. It being made ground, it is possible that this one point may have settled, but not enough to make any perceptible difference with any practical use that may be made of it.

CITY SURVEYING.

BY C. C. STOWELL (MEMBER).

City surveying implies two distinct branches of surveying each requiring different methods. First, original surveys or subdivision work; Second, resurveys, or tracing the original surveys, sometimes (usually years) after the subdivision has been made. Little can be said of the first except that it requires care and skill in fixing the boundaries of the subdivision, careful measurements and care in placing monuments. In subdividing the land, care and study should be given to secure good drainage, the best grades for the streets, and ready access from the streets and alleys to each lot. Unfortunately this is not usually delegated to the surveyor, but is done on paper by the property owner or real estate agent with the prevailing idea of its best appearance on paper and the greatest number of lots. I recall one subdivision, situated on the outskirts of a city, on a steep side hill cut by ravines, the whole surface rough and broken and wholly unfit for either residence or business purposes. Yet this was divided (on paper) into lots 22x100 ft., and the river, steam railway and highway, which were near the property, were shown on the map to convey the idea of advantageous location. The owner took his plat out of town and exchanged the whole subdivision for a lot of horses at an extravagant figure. Part of the subdivision has since been sold for a gravel pit for a low price, but no other part has been sold. To prevent such impositions on the public and to secure care in making the survey, our State needs laws similar to those of Michigan.

The second branch of the work, that of determining property lines by retracing a portion of the subdivision, requires much more attention, also good judgment as well as skill with transit and tape. The surveyor's first work in connection with this is to get an accurate description of the property. This is not always easily accomplished. Many times the property, even when in a subdivision, is described by "metes and bounds," and does not contain data of sufficient precision to be of much value to the surveyor. Indeed, it is often necessary and usually advisable, where property is described by "metes and bounds," to get descriptions of adjoining property.

Having obtained the description and checked the data given, the monuments are to be found if possible. The monuments in most of the cities in which the writer has done work had mostly disappeared except in subdivisions recently made. Indeed most of the records will show that very few monuments of a permanent nature have been used, wooden stakes usually being used for this purpose.

Where the boundary monuments cannot be found, a study of the whole subdivision must be made as it is marked on the ground by fences, etc., before the surveyor can fix the position of the property line in question with any degree of certainty. In this work careful and extended study and good judgment are absolutely essential to good results. Where the property lies in two or more subdivisions, it will usually be necessary to study each subdivision, with the property contained therein, independently of the others. It is quite likely that the surplus or shortage in one will be quite different from the other.

It is the usual custom, after the surplus or shortage in the subdivision has been ascertained, to distribute it proportionately among the lots, giving to the streets and alleys the actual width called for in the plat. Some surveyors give to the lots of uniform frontage, the distance given in the plat and put all the shortage or surplus, due to the block in the irregular lot at the end of the block. They give as their reason that these lots were intended by the party plotting to adjust all errors in the work. I doubt if this method would be sustained by the courts.

When a part or all of a subdivision lies on low, marshy ground, considered of little value, as along our lakes and rivers, the original survey has usually been indifferently made, the transfers indifferently made, and the ground, as it became of value, has been occupied with little regard to property lines. The result is a tangle that only the property owners by mutual agreement or the courts can adjust. In one case a survey was made for a corporation on ground along a lake shore, where buildings of more than ordinary value and one end of a bridge were outside of the right of way.

A few cities in our State have made resurveys of streets and alleys and placed monuments of a more or less permanent nature, but each city uses different material and places the monuments at different points. I prefer to place them either at the block corners or at the intersection of lines 1 ft. to 1½ ft. outside of the block lines. If the monuments are out a short distance from the property line they are less likely to be disturbed in the construction of buildings or sidewalks, especially where the walk is placed 1½ ft. from the property line.

In our prairie country iron pipes or iron rods about 4 ft. long and not less than ¾ in. diameter, seem to give satisfaction. Iron has an advantage over other material in that it can readily be found with the magnetic needle when covered with ice and snow or when 6 to 8 in. under ground or under a sidewalk.

JUDICIAL ELEMENTS IN SURVEYING.

BY W. D. JONES (MEMBER).

Surveying is something more than running straight lines and making accurate measurements between known points. It is that as a branch of engineering, but as a branch of law it is determining what the known points and what the controlling points of the survey are.

A property line always is where it always was (in theory, at least). If a property line is lost, it is not therefore, necessarily the business of the surveyor to locate it where it should have been located, but rather to find where it was, and therefore is. If the original monuments exist, they must of necessity be the best evidence of where the line is, unless there is good evidence that they have been moved. The surveyor who is retracing old lines must decide, 1, whether what he finds are original monuments, and 2, whether or not there is any good evidence that such monuments have been moved. Sometimes (as a matter of policy) he must decide whether or not the surveyor whose name is recorded as having set those monuments would admit that he set them where they are found to be. A knowledge as to whether the said surveyor is alive or dead, and if alive, a general knowledge of his disposition and character, is of much value in making this decision. It is generally conceded that the most perplexing questions to a surveyor arise where the original monuments have been lost for years.

In the case of country surveys, each lost section corner and quarter section corner is a case of itself, and the surveyor is called upon to collect all the evidence as to the location of the same, both in form of old trees, fences, stakes, gradings, ditches, etc., and in form of testimony of old residents. He must judge which man is greedy and which one is honest; he must judge what is and what is not evidence. In short, he must conduct a court case of his own, always remembering that if he has erred in his decision, it is likely to be reversed by a higher court where additional evidence will be admissible.

In the case of city surveys, the re-location of lost lines in very old subdivisions depends more, of necessity, upon measurements from and between known points and lines. It is again the function of the surveyor to decide what points and lines are known. Well defined old possessions equally jealously guarded by opposite interests is good evidence of the location of lines. A starting point, in case it is a street line, and has not therefore been very closely guarded by a city, may not be as important a point as intermediate lines of possession in a subdivision. If all the lines of possession agree proportionately with the recorded dimensions on the plat of subdivision, the survey is simple; but if they disagree the surveyor must decide what is important and what not important, which is best, and whether or not there is important disagreement. In case there is strong enough conflict in the controlling points of a survey to make the surveyor hesitate at all between two theories, he is hardly called upon to make and report a definite decision, but will better serve the interests of his client by reporting the facts just as they are and advising his client to seek legal opinion. Some surveyors may think it would be very derogatory to their reputation to report such facts, but not long ago the writer had occasion to make just such a report and for his pains received an unasked and unlooked for letter of thanks and high commendation from his client. We need not be afraid of facts; they never injure conscientious workers and honest men.

Another thing which a surveyor must decide is the amount of accuracy that should be given to any survey he is to make, and at the end whether he has given said survey the care it should have. Some of you will say any survey should be made with absolute accuracy. That is easily said, but cannot be accepted. While the theory that the value of the property governs the care of the survey is made the scapegoat for very much extremely careless work, nevertheless, it is a condition that does and must govern us all to some extent. If the object of the survey is the definite location of a property line, it pays to make it a little more accurate than any other surveyor would make the same survey; but it does not pay to survey land worth $15 per acre as carefully as to survey property worth $1,000 per foot.

The purposes of the survey also affect the degree of accuracy; for example, park subdivisions, such as Riverside and Lake Forest, should not necessarily have their street lines so accurately recorded that a brick wall could be built upon them to an exactness of half an inch. The interests of the property owners are best served if the designing of such subdivisions is left to a good landscape architect. And we all know a landscape architect cares absolutely nothing about an engineer's mathematical lines. He puts in long sweeping curves for beauty alone and the more irregular they are, the more beautiful they seem to be. Any attempt upon the part of the surveyor to twist the said curves into a succession of regular curves is not only very expensive but quite certain to destroy their beauty and hence make them worthless. The better method has been adopted of recording certain important points definitely and leaving intermediate locations to the judgment of the party making improvements on the ground. A surveyor must not make his surveys cost more than the property he is surveying is worth, or more than the scheme they are made for is worth, but he must make them correctly represent what they purport to represent. He must consider the interests of his client, the rights of his client, the rights of adjoining property owners, and the rights of himself. He will best do this when he has done justice in every way to all concerned.

LAND SURVEYING IN NORTH MISSOURI.

BY WILL DOWELL (MEMBER).

In having troubles of his own, the county surveyor of north Missouri is but little behind those of any other country. The government survey was made between 1820 and 1845, and very few of the line and bearing trees remain. Of course the original posts are all gone. In the prairie districts the charcoal corners can usually be found, unless they are on a public road. Few of the stone monuments that were set where the public roads are now located can be found, the road overseer as a rule having dragged them out with his grader at the earliest possible moment, regardless of the penalty. Until within the last few years land has been cheap, the price being from $8 to $20 per acre; few substantial fences were built and owners were not very particular about their lines. In fact many of the existing lines were run by a local surveyor without either field notes or suitable instruments, and in many cases without mathematical training or experience. In other cases the owner himself measured the distance (sometimes by pacing) from some known corner, perhaps in a different section, and set his own corner at 20, 40, 60, 80 or 120 chains, as the case might be. This land being now worth from $60 to $100 per acre, the farmers are building permanent fences and are more exacting in the matter of land lines. The country is being filled up with people of means from the older states, who, as a rule, care more for permanency in their land lines than for a few inches of soil, and who require their corners to be properly established. In doing this the surveyor frequently disturbs some of the carelessly run lines of the "old settler," and either gets into trouble himself or plunges the whole neighborhood into litigation. Of course we all realize that we should be careful in disturbing old lines, but what shall we do? I can conceive of but one logical answer—set the corners according to the public land law and let the courts do the rest.

An old settler (whom I will call "A") owned the southwest quarter of the northeast quarter of section 26; 35 years ago a local man surveyed this tract and one of his note books shows he did the work as follows:

> Commencing at the north one-fourth section corner of section 26, I ran south with a variation of 9° east
> at 20.00 chains set a limestone,
> 40.00 chains set a limestone, thence east
> 20.00 chains set a lost stone, thence north
> 20.00 chains set a limestone, thence west
> 20.00 chains to limestone first set.

The limestone at 40 chains on the line first run, and which the surveyor evidently set for the center of the section, is 30 feet east and 13 feet south of the place for the legal center of the section. The northwest quarter section had until recently belonged to "D," who sold the west half to "C," and the east half to "B." "C" claimed that as "A," whose deed called for the southwest quarter of the northeast quarter, owned all land embraced within the corners before noted, that this southwest corner was the true center of the section, whether placed right or wrong, and that it should be so considered in the subdivision of the section. I tried to explain to him that the fact of "A" having by a court decision acquired title to land that was originally in the southeast quarter, did not take the land out of that quarter, and could not have a bearing on any lines except those bounding his own land. My belief was that the court can through the statute of limitation, alter the boundary lines of farms, but this act does not alter the sectional subdivision lines. I subdivided the section as though there was no statute of limitation, and received some beautiful titles for doing so.

The blank quarter section corner had been set—no doubt by the farmer himself—on the north boundary of section 4, in such a manner that it did not suit the calculation of areas as expressed on the official plat. It had, however, been considered the true corner for many years. The owner of the southwest quarter section sold the west half of it and a surveyor was called to divide the quarter. He re-established the blank quarter section corner as the law provides and proceeded to make his surveys accordingly. He did his work accurately but went away without offering a word in explanation. There was talk of a law suit and one of the parties asked for my opinion. I told him that as the old corner had been used in running former subdivision lines, and the owners had regarded the lines so run as correct, the courts would no doubt hold the present lines to be the true boundaries of the several tracts of land so surveyed,but I thought they could not be held to be the true sectional subdivisional lines, and that the surveyor had made a proper and legal subdivision of the southwest quarter.

A few section corners are found which have been re-established in accordance with an old state law which provided that it should be legal "to commence at any two section corners in transverse directions from the corner sought, and run random lines in the direction thereof to the quarter section corner; note the falling therefrom; then, adjusting the compass to the true course of said lines, respectively, continue the true course of said lines, and establish the corner sought at the point of intersection thereof." As the quarter corners were seldom placed, originally, in a right line joining the section corners, and the error in re-establishing the section corners by this method is double the error in the original quarter section corner, it is little wonder the monuments set in accordance with this law fail to check with the usual method for the re-establishment of section corners.

I make it a rule to run lines by fore and back sights, without using the needle. In starting random lines I usually measure the angle between the line and some permanent object, using the plates and vernier, and reading the angle to minutes. My record then enables me to retrace the random or run a true line from the corner should it ever become necessary to do so. I furnish each chainman with a plumb bob and see that he uses it in chaining over rough ground, keeping the tape as nearly level as possible. I have them set a stake on the line at the end of each ten chains in level and five chains or less in rough or timber land. I mark the stakes in such a manner that I can go back on the line and resume the line and measurement from any stake. This is very convenient in marking the intersection of two lines.

Whenever possible I mark my corners by planting a cement or concrete shaft, 4 ins. diameter and from 2 to 3 ft. long, with a cable (made from three No. 12 wires twisted together) running lengthwise through its center. The cable should protrude about a foot from one end of the shaft. In setting, I have the chainmen stretch the chain over the corner in such a way that some mark on it (say the 15 foot graduation) is directly over the corner. The chain is held taut and a tally pin set at the 5 ft., and another at the 25 ft. mark and left standing until the shaft is set. The hole is made by using an 8 in. post auger, the chain stretched as before, the shaft placed in the hole and lifted by the protruding cable just enough to swing clear of the bottom, the cable brought to the 15 foot graduation and the shaft allowed to settle to the bottom of the hole. It is then tamped in this position and the cable clipped off close to the top of the shaft. If the tamping is carefully done the cable will mark the exact corner as effectively as a tack point, no matter how much is broken or worn off the top of the shaft. Monuments to be set in public roads should be 6 or 8 ins. in diameter and have five cables, one in the center and the other near the circumference; such a monument gives the road overseer and his road machine very effective resistance, but may be set with the top below the road surface and witnessed by smaller monuments at the road side if desired.

OFFICE METHODS IN RAILWAY SURVEYS.

BY W. D. GERBER (MEMBER).

The making and keeping of thorough and accurate office records of railway surveys is one of the most important features of engineering connected with the location and construction of a line of railway. It seems to have been the practice for each engineer or engineer's office to make these records and to file them according to their own individual ideas, consequently the need of an accurate system for making and keeping these records is an interesting subject for office engineers.

It has been our practice to do as little work in the field with the location party as is possible. By this I mean that only working profiles and projecting plats are made in the field. As the survey progresses and a certain length of line, say 15 to 20 miles, has been definitely decided upon, the notes are returned to the office where they are carefully checked and from them the maps and profiles made.

MAPS—In making up location maps, two sizes of scaled drawings are made, one which we term our location map, made on a scale of 2,000 ft. to the inch. On this plat or map is shown the line, with all the notes relative to the alinement, together with the station numbers and land line ties; land lines such as section and half section lines or smaller subdivisions where owned by different individuals, and the names of the property owners. No topography is shown on this map except streams of considerable size or which have water in them a considerable portion of the year.

The second map, or the one we commonly call our right-of-way map, is made up in a continuous roll, 18 ins. wide, 500 ft. to the inch. On this are shown all notes relative to the location, similar to the smaller scaled map, and also the right-of-way for which deeds are secured. Upon securing a deed for a piece of right-of-way and after same has been checked and recorded, a record is made on its proper parcel of land, giving the number of acres taken, price paid and the index of the filing. This then becomes a perfect office record of the right-of-way throughout the whole length of line plotted thereon. On this right-of-way map are also indicated the country highways, the location of any considerable improvement which lies close to the location, together with such topography as can be secured without resorting to taking of notes for contour lines. It has not been our practice to show contour of lines through this Territory (Oklahoma). I doubt if any other road has gone to this extent in its map making.

Following the location and right-of-way maps, naturally comes the center line profile of the line. This profile is made on profile tracing paper with horizontal scale of 400 ft. to the inch and vertical scale of 20 ft. to the inch. The grade line is laid as it is expected to be built. The alinement is placed along the bottom with the curve notes so that one may readily see how much of a cut or fill is to be had or met with at any particular point, whether on tangent or curve. Our roadbed when finished is 16 ft. crown for fills and 20 ft. base, with 4 ft. ditches on either side in cuts. This leaves a 12 ft. crown for roadbed through cuts. Our specifications require the contractor to haul 300 ft. free; overhaul to be paid for at so much per yard for each 100 ft of overhaul. In making up the estimate from the center line profile, these notes are naturally carried in mind.

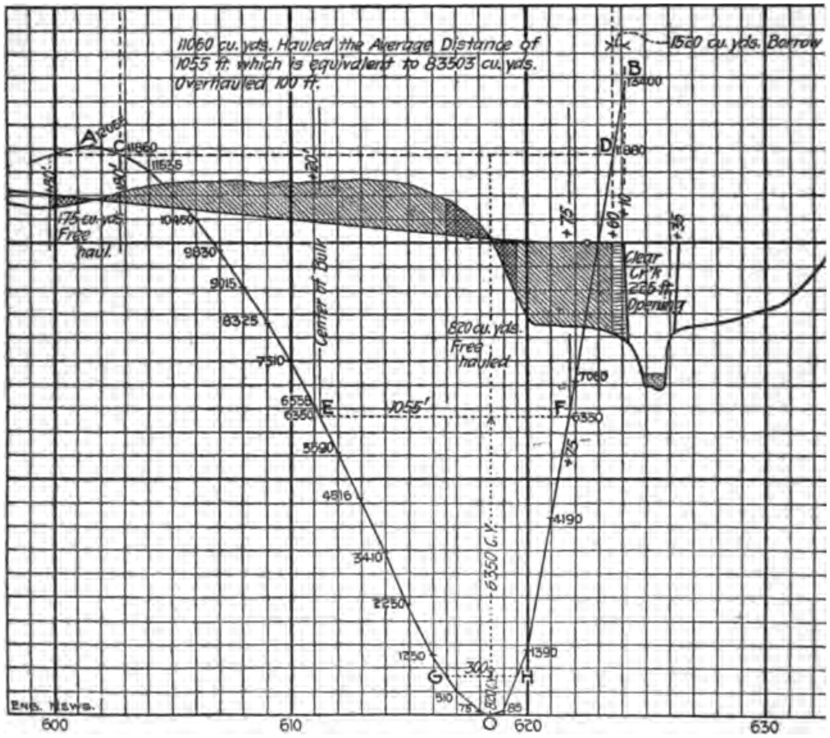

DIAGRAM FOR ESTIMATING OVERHAUL: DENVER, ENID & GULF RY.*

PRELIMINARY ESTIMATE—The method of working up the preliminary grading estimate is similar to that illustrated in the "Manual for Resident Engineers," by Molitor & Beard. A section of profile is herewith presented. The average end area, or rather the average center height, of any prismoid is found by scaled measurement, using a scale of 20 ft. to the inch. The cubic contents is then found by reference to some table of level cuttings. To the excavation quantities thus found are then added all extra yardage on account of ditches, etc. With a vertical scale of 1/20 in. equal to 100 cu. yds., and with some horizontal line as a base line, construct the bulk or mass curves, starting at a point on the base line, directly under the grade point as at "O." By scaling and with reference to the table we find that the embankment portion of the grade between station 618 and station 619 contains 85 cu. yds. The next 100 ft. prismoid contains 305 cu. yds; the next 2,800; the next 2,870, etc. Then beginning at "O" the bulk curve O-H-F-D-B is plotted for the embankment. Similarly the bulk curve O-G-E-C-A is plotted for the excavation portion of the work. Since the specifications require 300 ft. free haul, draw the horizontal line G-H exactly 300 ft. long, measured with a scale of 400 ft. to the inch. The points G and H indicate the extreme limits of the free haul and the vertical distance between G-H and O measured with scale of 1/20 in. to 100 cu. yds., represents the number of yards hauled free, which in this instance, is 820. The points G and H are then projected into the profile and the free haul work is indicated as shown.

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*This illustration furnished by courtesy of the Engineering News Publishing Co., New York.

We will suppose it is desired to haul all of the excavation possible between station 601+50 and 618+40 into the embankment, consequently we would proceed to find the free haul quantities at the left or east end of the cut in the manner just described, which gives us station 599+80 and 602+80 as the respective limits of free haul with a quantity of 175 cu. yds. hauled free. This leaves us for excavation the quantity of material represented by the bulk curve D-E-C. Draw C-D, (a horizontal line through C) to an intersection of the embankment curve at D. This line then represents the length, when measured with proper scale, of extreme haul. By bisecting the vertical distance between the lines C-D and G-H and drawing through this bisecting point the horizontal line, E-F, to intersections of the mass curves at E and F we obtain the center of bulk or mass. The length of this line represents the mean haul for the cubic yards of material represented by the mass curve between G and C, which is 11,060 cu. yds., or the total excavation yardage minus the sum of the two free haul quantities. The result of this work now stands as 11,060 cu. yds. of earth excavation hauled the average distance of 1,055 ft., but the specifications recite that each yard is to be hauled 300 ft. free, hence we have:

11,060 cu. yds. hauled 1,055 ft.
=11,060 cu. yds. overhauled (1,055—30) 755 ft.
=83,503 cu. yds. overhauled 100 ft.

We have now accounted for all the yardage in the excavation but are still short the amount of embankment represented by that portion of the embankment curve between D and B, or 1,520 cu. yds. This amount of work must of necessity, then be borrowed and it is so indicated on the profile. Quantities which are wasted are also indicated in a similar manner.

It is very likely that one of the first questions which will arise regarding this method of estimating the grading on any piece of work will be, "What is the percentage of error of such an estimate as compared to the actual quantities as computed from the cross section notes?" We are just finishing some 15 miles of grading of which some seven miles has been completed. On comparison of the quantities found by this method of preliminary estimating and the quantities of actual work done, I find that the quantities of the latter over-run those of the former by 6.2%. On one particular mile, which is a fair representative of the general work found in this country, I find that the final quantities over-run the estimated quantities by 2.5%. In conversation with several engineers of experience who have been familiar with this method of estimating, I have learned that they do not expect to find, under ordinary conditions, an error of more than 5 to 6%, which goes to show that this is a very fair and accurate method for preliminary estimation of quantities.

Following the preliminary estimate of grading, comes, of course, the preparation of a preliminary estimate covering the total cost of the finished work. This is made up from the total estimated quantities of the different materials required, together with the current prices for such material and as it resolves itself into the question of simple multiplication, requires no further discussion.

MONTHLY REPORTS OF CONSTRUCTION—Upon the organization of the residency party, the first work of course, is the checking of all level, alinement and land line notes and the correction on the maps and profiles of any errors thus found. Upon the commencement of actual construction, monthly reports are made to the office of the Chief Engineer covering all the different departments of the construction. Where pile bent bridges are built, the resident engineer is also required to keep a record of the length of all pile penetration and cut off and the number of board feet of all lumber used in the deck and bracing. From these monthly reports a progress profile is made showing in different colors, the work done for each particular month. This profile, together with a monthly estimate of all work done, is forwarded to the General Manager that he may keep himself thoroughly informed as to the progress of the work at all times.

Upon the completion of each contract or any considerable portion thereof, a final profile is made and the hauled quantities computed in the same manner as described for the preliminary estimate, with the exception that the cubical content of each prismoid is found from the cross section notes. This profile is a complete record of every yard of material handled and final payment for the grading is made from the information shown thereon.

There is one other record of importance in connection with this subject and that is the keeping of station ground plots. These plots are made to a scale of 50 ft. to the inch (whenever possible) and show in detail the property acquired and occupied as station ground. On these are kept a record of all leases for industries on the railway right of way with shape, size and location of any buildings erected thereon. On these plats are also shown all tracks within the yard limits; the right of way boundary corners; street intersections, together with all buildings erected or used by the railway company in connection with the operation of its system.

SURVEYING AT THE UNIVERSITY OF ILLINOIS.

BY LESLIE A. WATERBURY (MEMBER).

It is the purpose of this paper to describe the work which is done by the classes in surveying at the University of Illinois.

COURSES FOR CIVIL ENGINEERING STUDENTS.

All regular civil engineering students, and students in municipal sanitary engineering, are required to take surveying during all of the sophomore year and the first half of the junior year. During all of this time five semester hours per week are devoted to the subject. (One semester hour is considered as the equivalent of three hours' work, which may be either one hour in recitation for which two hours' preparation are required, or three hours drafting or field work for which no preparation is required.) For field work, during the sophomore year, the classes are divided into squads of two men each. The same two men work together during the entire semester and usually throughout the year. At present there are six sections in sophomore surveying which are in charge of three instructors so that each instructor has about ten squads to oversee at any one time. During the junior year the classes are divided into parties of eight or nine each. This year there are eight parties which are under the charge of two instructors, each instructor having two parties in the field at each field period.

1st. The work is intended to familiarize the student with the instruments and general methods employed in surveying. The text books used are Baker's "Surveying Instruments" and Pence and Ketchum's "Surveying Manual." During the fall and early winter, while the weather is suitable for field work, recitations are not held oftener than twice a week, the other three periods being devoted to field work. When the weather becomes unsuitable for field work, recitations are held five times a week excepting a few periods which are occupied with indoor problems such as stretching cross hairs, determining the radius of a bubble vial with a level, trier, etc.

RECITATION WORK. The subjects which are discussed in recitation are: (1) field problems for which explanations or directions, other than those given in the manual are needed; (2) the construction, use and adjustment of surveying instruments; (3) land surveying; and (4) computations.

The study of land surveying includes more than is given in either of the text books mentioned. The method of recording surveys, the certificates which should be attached to plats for record, and the various records from which useful information for resurveys may be obtained are explained. Computations include a study of the determinations of areas of field by different methods: A, by the perpendicular method for which the field is divided into triangles in each of which a base and altitude are known; B, by the three-side method, for which the field is divided into triangles of which all the sides are known; C, by the angle method, having the field divided into triangles for each of which one angle and two adjacent sides are known; D, a field having a curved boundary; E, by latitudes and departures; F, the distance across a body of water, by triangulation; G, the height of a tower; and H, the quantities necessary for a determination of a true meridian by means of the solar transit. Besides the study of these determinations, attention is given to short methods of computation, methods of checking calculations, and errors of surveying.

FIELD WORK. The field problems which are done in the first semester of the sophomore year are about as follows:

Pacing, ranging, ranging lines by eye, distance with chain and tape, angles of a triangle with tape, survey of field with tape, prolongation of a line past an obstacle (with a tape), determination of an obstructed distance (with a tape), determination of the declination of the magnetic needle, angles of a triangle with a compass, traverse of a field with a compass and chain, differential leveling with a hand level and engineer's level, profile leveling for drain (to complete this problem a profile showing the proposed location of the drain is required), levels for street paving (to complete this problem a profile showing the proposed grade line for pavement is required).

Contour leveling. (An area of about 1¾ acres of rolling ground is divided into 25-ft. squares and ground elevations are taken at the corner of each square. A contour map of the area is required showing contours for 1-ft. intervals.) Reciprocal leveling, determination of radius of bubble vial, tests of a telescope, Y level and dumpy level, transit work for angles of a triangle, prolongation of a line and intersection of lines, triangulation across an imaginary river, traverse of a field with a transit and tape, staking out a building, height of a tower with a transit, tests of a transit, plane table map by radiation method, by traversing and by intersection method.

OFFICE WORK. In addition to the work already described, each student is required to make seven lettering plates and each squad is required to go to the county recorder's office and find the abstract of title and notes for a resurvey of an assigned piece of property.

2nd. The work in surveying done by the regular civil engineering students is divided into two subjects: topographic surveying, and railway curves.

TOPOGRAPHIC SURVEYING. The class in topographic surveying meets four times a week, the credit given being four semester hours. The text used is Wilson's "Topographic Surveying," upon which recitations are held once or twice a week. The remainder of the time is devoted to topographic drawing during the first part of the semester, until the required number of plates have been finished, after which this time is devoted to field work.

The principal items which are discussed in recitations are: Topographic drawing, including methods of map construction, contour construction and conventional signs; classes of map surveys and their uses; features shown on topographic maps; accuracy desirable in topographic surveys; the U. S. Geological Survey methods used in different kinds of country; detailed topographic surveys for railway and canal location, reservoir sites, dam sites and town sites; cost of topographic surveys; geographic and exploratory surveys; military surveys; topographic forms; plane table topographic surveys; stadia and angular tachymetry; spirit leveling; precise leveling; adjustment of level circuits; trigonometric and barometric leveling; methods of measuring base lines; primary traverses, and primary triangulation.

Eight plates in topographic drawing are required, upon which are shown most of the topographic signs commonly used. The last plate is a copy of a small scale topographic map. There is also required of each squad a large scale topographic map of a portion of the campus. The field problems in topographic surveying are as follows:

Adjustment of a transit and a level, determination of a stadia constants, azimuth traverse with stadia, angles of triangle with sextant, angles by repetion for a portion of the triangulation system, measurement of base line with tape, topography with transit and stadia, and with plane table and stadia.

The data obtained from the last two problems is used for the topographic map required. In addition to the foregoing problems, the calculation of a small triangulation system is required.

RAILWAY CURVES. The subject of railway curves, which is given in the sophomore year, is intended to prepare the student for the work in railway surveying which is given in the junior year. The class meets once a week and the credit given for the subject is one semester hour. The text book which has been used heretofore is Nagle's "Field Manual for Railroad Engineers," but this year Allen's "Railroad Curves and Earthwork" will be used. The first portion of the semester is devoted to recitation work covering the solution of curve problems, the general methods of location and earthwork computations. When the weather becomes suitable, the classes are sent into the field to lay out curves. Some other field work is also done, such as getting slope stakes, mapping railway yards, etc.

1st Semester, Junior Year. The surveying work given to the regular civil engineering students, in their junior year, is railway surveying. The credit given for this subject is five semester hours. At present the class meets five times a week, but it is the intention to change this arrangement, making fewer and longer field periods, in order that less time may be lost in getting to and from the place of work. The text books used for this subject are: the text used for railway curves, Talbot's "Transition Spiral," and Tratman's "Railway Track and Track Work."

The subjects in the field manual are first considered in recitation work. A short review of curves and earthwork computations is made, to get the student into shape for good work after his summer vacation.

The method of railway location is then considered in detail, a careful study being made of reconnoissance, preliminary surveys, and location surveys. Other items considered are: field parties and the duties of the various members; map construction and methods of projecting lines; calculations pertaining to frogs, switches, turnouts and yards; calculation of overhaul; the plotting of mass diagrams, and transition curves. The economic theory of railway location is also discussed, but is not given in any of the text books mentioned. The latter portion of the semester is devoted to a study of roadbed cross sections, track and track maintenance.

FIELD WORK. Each squad of eight or nine men is expected to locate and cross section one mile of a proposed line, from a given station to a given tangent. A somewhat hurried reconnoissance is made; the general route which each squad will follow is selected; a preliminary line is run by each squad; topography along the preliminary line is taken with a hand level; the preliminary line and topography are plotted, upon which map a paper location is prejected; the location line is run, taking offsets to the curves, and later connecting the curves and tangents with transition spirals; levels are taken along the location line; a profile of the location line is plotted, upon which the grade line is shown; the line is cross sectioned, slope stakes being set opposite every station; the quantities of earthwork are computed, and a mass diagram is plotted. The design of railway structures is not considered because it is taken up in a separate course in the following semester.

COURSES FOR OTHER ENGINEERING STUDENTS.

Students in mechanical, electrical and architectural engineering, and students in architecture are required to take at least two semester hours' work in surveying. For this purpose a special course is arranged, in which classes meet twice a week during the second semester. The text book used is Pence and Ketchum's "Surveying Manual," covering which recitations are held during the first part of the semester, while the weather is unsuitable for field work. The work during the latter part of the semester is devoted principally to field work. For this purpose the classes are divided into squads of about four each. Each squad does as many tape, compass, transit and level problems as time will permit, most of the time being devoted to ordinary transit and level problems.

The College of Agriculture offers a course in drainage and irrigation to students in agriculture, which course is entirely separate from the work of the civil engineering department. The credit given for this course is 2½ semester hours. The class meets five times a week for half of one semester. The subjects considered are: location of drains and irrigation conduits, leveling, trenching and laying tile and pipes, filling and subsequent care; cost of construction and efficiency; sewers for the disposal of waste water from farm buildings and sewage from kitchen and toilet room, and farm water pipes and thread cutting. During the pleasant weather the classes do field problems relating to drainage surveys.

The portion of the campus upon which most of the surveying problems are done, has upon it a large number of permanent monuments which can be used. These monuments consist of iron pipes bedded in concrete, with a cap having a definite point at the top of each pipe. A number of these points are arranged upon a spiral and the others are arranged to form a triangulation system. Last fall a second temporary spiral, similar to the first, was located to accommodate the increasing number of students. The points upon the spirals are lettered and the points upon the triangulation system are numbered. Each squad is assigned a particular field (as A-R-S-U-J) upon which to work. The arrangement of the points upon a spiral makes possible a large number of such combinations, so that each squad can usually be given a different field.

The University has a standard for each of the following: length, elevation, direction and position.

Standard of Length. The standard of length is 100 feet, U. S. standard, laid off between graduations on two copper bolts set in heavy concrete posts.

Standard of Elevation. The principal bench mark from which level circuits are run, consists of a steel bolt leaded into the south capstone of the east entrance to University Hall. The elevation of this bench mark, above sea level, is taken as 720 feet.

Standard of Direction. The standard of direction is a meridian which was established with the transit in the old astronomical observatory. This meridian is perpetuated by a series of metal monuments bedded in concrete, of the kind already described.

Standard of Position. This standard is a monument of the kind just mentioned, which is set at triangulation station 0 (zero) which is at the intersection of the principal meridian with the primary base line. The latitude of this monument is 40°-06′-38.1″ and its longitude is 88°-13′-37.6″, which values were determined by connecting triangulation station 0 (zero) with the primary triangulation of the U. S. lake survey.

THE LAND SURVEYOR.

BY H. H. BREMER (MEMBER).

The word "Surveyor," at one time easily understood, must today have a prefix to designate the particular field in which it is to be recognized. We hear customs collectors and insurance agents spoken of as surveyors. An ordinary dictionary definition is not clear, thus: "Surveyor—One who measures land; an inspector of goods; highways, etc." For the purpose of this article, let us designate the Land Surveyor as "A person of knowledge in mathematics and the principles of surveying, who locates, measures and computes the areas of land," and for brevity let us call him Surveyor.

The surveyor occupies the peculiar position in law and society of being neither a professional man nor a laborer. Yet society frequently calls upon him to act as arbiter in disputes and forces upon him the duties of judge, jury, lawyer and witness. Through his ability and honesty of purpose, disputes are adjudicated. Honesty and the pleasure of laboring in a chosen field are probably inborn in the average man. Eliminating these unknown quantities, and ability makes the surveyor. By ability I mean the skill and requisite knowledge of correctly doing the work.

Through the laxity of the law in this State, it is possible for the possessor of the rudiments of arithmetic, coupled with the ownership of a transit, tape and pins, to hang out his shingle—"Surveyor." As to such refinements as geometry, trigonometry or algebra: "They are not necessary," "A surveyor is not an engineer," "Triangular tracts of land are scarce anyway," and "The surveyor is busy and will not be able to attend to this matter for a couple of weeks." These are remarks which I have heard in the last few years. Within the past year an estimable fellow surveyor, employing a number of assistants, told me that the ability of his principal assistant surveyor was limited to surveying rectangular lots. This assistant stakes off for building purposes an average of two lots per day, with a possibility of 600 lawsuits a year.

An attempt was made about three years ago by this Society through a committee to interest the Legislature of Illinois in a bill for the licensing of surveyors. The bill, as drafted, took for an ideal the architect's license law, and adapted it to the surveyor. It was known as "Senate No. 179—42nd Assembly," and as such it was duly buried. This bill was faulty in many ways. It failed to give a clear definition of land surveyor. It created an examining board with unlimited power, which could issue licenses to whom it wished at its pleasure. It made the board a court of record, whereas any existing court of record should be sufficient for the purposes intended. This bill gave power too extensive to the surveyor, when it empowered him to take under oath "Evidence—useful in establishing—a survey." As a rule a surveyor does not know how to take evidence according to the "rules of evidence." The bill was properly killed, if for no other reason than that it give consent to the issuing of licenses to incompetents who had been engaged in the land surveying business for a period of not less than five years.

It become more obvious as time passes that certain restrictions must be placed on incompetence and dishonest practice. For instance, witness the number of contests at law and otherwise, due to the variance of surveys, most of which variances are due to lack of comprehension of the fundamental principles of surveying and "the rule of three." It is a matter of public policy that the Legislature be asked to pass an act providing among other things:

1st. For uniform examination for license for all engaged in the business or occupation of making land surveys; said examination to be under competent direction and held at a stated place and time at least twice a year. Examiners should be disinterested practical men of recognized standing in the business of surveying or teaching and successful candidates for license to obtain at least 75 points in said examination.

2nd. To provide a system for keeping a complete record of field notes and plats of all surveys for public inspection to be filed with the recorder of county in which such survey is made at the end of each calendar month. Said notes and plats to be transcribed from the original in special books, provided by the surveyor and attested by him, at the end of each month. This should be properly indexed by the recorder for a fee of say 10 cents per survey.

3rd. To provide a salary for the elected county surveyor and assistant. The duties of said official to consist in making such surveys and plats or maps thereof, as may be required by the county in which he is elected and the abolition of the fee system connected with the office at the present time.

It may not be feasible for one man to carry the burden of many to the General Assembly of this State, but it is a matter of general policy for our Society to take this matter in hand and endeavor to bring it to a successful issue.

REPORT OF THE COMMITTEE ON SURVEYING.

No legislation affecting the surveyor has been enacted during the last 12 months. This is to be regretted as a matter of general principle. Favorable legislation on the licensing question would be a boon. Adverse legislation is better than none at all. It will stimulate interest in the subject and produce results of some kind probably unlooked for. It is recommended that the Society appoint a committee which will ascertain the sentiment of the surveyors of Illinois in this matter, draft a bill and use all honorable means to further its passage by the legislature.

Attention is called to the condition of government monuments and their perpetuation. Eastern committees are taking the lead in re-establishing old boundaries and lines and perpetuating monuments. Why not agitate this question in Illinois? It is to the taxpayers' interest that government corners be preserved and he should pay for their re-establishment. In cities, towns and villages section corners are obliterated to make way for street improvements. Their location and preservation should be made obligatory by law.

The Federal Government in conjunction with the State is engaged in making a topographical and geological survey of Illinois. Published maps show this work in large areas but fail to sectionize it. It would appear that the value of the work would be greatly enhanced to the engineer, surveyor and layman if this were done. Attention is further called to the various datum planes assumed by communities in establishing grades. It is recommended that datum planes be referred to some fixed level throughout the State. It would be convenient to use sea level, and refer datum planes to it.

H. H. BREMER,
S. N. HOWARD,
J. T. STEWART.

DISCUSSION ON SURVEYING.

MR. GREELEY: One serious difficulty in the way of securing legislation regarding surveyors and surveying is the lack of interest in the subject among the people at large. The only persons really concerned are the surveyors themselves and a few land owners. The capital invested in the business of surveying, as compared with the vast sums invested in farming, manufactures, railways and other great industries, is almost nil; it is a very petty interest, and nobody, except a few surveyors, cares enough to petition the legislature for laws in its interest. The main difficulty lies perhaps in the conflicting views of the friends of legislation. One provision insisted on was that persons who had been engaged in the practice of surveying for a certain term of years should be entitled to a license without examination. This was strongly objected to; but a small group of men, who were perfectly competent and reliable surveyors, feared that they or somebody else might be unable to pass a technical examination, and they threatened to "kill" any bill not containing that provision. Then, following the architects' license bill, a section of the proposed bill provided that one member of the examining board should be a professor or instructor in the University of Illinois. This inspired a fear that the examination would be academic, and as such, would bar out some men of ample practice, but limited theory.

MR. McCLANAHAN: In Monmouth I had metal posts cast; 10x10 ins. at the bottom and 4x4 ins. at the top, 6 ft. in length, with a rod through. They were placed in concrete 20 ins. deep, and no change has been noted in 8 or 10 years.

MR. WATERBURY: It seems to me that the object of the proposed license law is to secure competent work by competent men. At present there are many surveyors who are perhaps not competent to do many of the things they should do. The office of county surveyor is at present a political office, which is one of the things tending to produce this condition. However, the reason that certain surveys are at fault is usually not because the surveyor does not try to do first class work, but it is, (1), because he does not know how to do certain kinds of work, through lack of training, and (2), because he does not appreciate the importance of certain things. The first deficiency can be remedied only by the surveyor himself, but perhaps this Society could assist in removing the second deficiency.

MR. RICKER: I have been connected with the architects' licensing board for the seven years since it was formed, and can state the result of some of these difficulties. Mr. Greeley has mentioned that the opposition would certainly have killed the surveyors' bill unless it provided for licensing persons for previous experience, without subjecting them to examination. Any architect who could prove to the satisfaction of the board that he had been in good and reputable practice at the time the bill went into effect (seven years ago), was entitled to the license. There were 800 applications. The board adopted the plan of acting on these liberally, because the license law would probably have been opposed by the people if an architect could not be found in any city or village of importance. So licenses were issued to 700 persons; of these probably 400 were really architects; the other 300 were contractors and made plans occasionally. Only 518 of these are now in force. The whole number will then disappear in about 20 years. There have been 153 licenses issued after examination, so that there are now 671 licenses in force. The fees were fixed by the law at $15 for examination, and $25 additional when the license was issued. The law requires the examination fee to be deposited by the applicant; but it is returned if he fails in securing a license. The revenue from license and renewal fees ($5 a year, if paid during July) have rather more than paid the expenses of the examination of the board. The law provides for two examinations annually, which have always been held, and three when found necessary. The examinations continue for five half days; each half day's work is marked on the basis of 100% for perfect work, and the percentages obtained each half day by each applicant are added together and divided by 500, so that the average is taken. For the seven years, the average for passing the examinations has been 70. New Jersey and California have architects' license laws. Similar laws were passed in Texas and in New York, but were vetoed. The laws of the first two states are both founded on that of Illinois. California has two license boards, with a joint annual meeting, but the State is divided into two districts. Many of these men who were licensed at first live in country districts, and have no opportunity to design buildings of any great importance, so that the board did not run much risk in licensing them. In the city, of course, it had to be much more careful. Every applicant was investigated strictly and he was required to name at least two buildings of importance that he had designed and built, as architect; then the secretary of the board in each case wrote, to the owners of those buildings, and made inquiry in regard to the work of the architect. If the proofs were entirely satisfactory, as well as the statement of the applicant, the license was usually granted. Some were considered three or four times, and 100 were finally refused. No young man enters the profession without at least a minimum amount of professional knowledge and experience, so that eventually this will rank as high as the medical profession, or any other profession in which examinations are required.

If the fees are renewed, the licenses are for life. If an architect fails to renew his fee during July, the license is revoked on Aug. 1, but there is no limit to the time within which the architect can renew it. He can drop it for any number of years, and when he sends in his fee for the renewal, the license is restored, and he is not required to pay back fees.

If any statement of bad work comes to the knowledge of the board (a formal complaint is not necessary) they investigate the case. We have had three or four cases of buildings falling down during construction. These were carefully investigated, either by members of the board or by experts employed by the board. The architect was cited to appear and explain, and, if necessary, to stand trial. If he was found to be negligent, his license was revoked for six months. At the end of that period he may apply for reinstatement, and if he can show proper and sufficient reasons, the Board may restore his license, but that is entirely at the discretion of the Board. A man can take the examination and if he fails it does not cost him a cent to take the next examination.

The law provides that any man in the employ of an architect regularly as draftsman or superintendent, subject to his direction, and for whom he is responsible professionally, may be employed by him and put in charge of the building. That fixes the responsibility on the architect, and the superintendent is simply his employee. I suppose it should be the same with a licensed surveyor. He employs transit men and level men. He is responsible for the accuracy of their work. Those men would not necessarily hold a license.

MR. FEENEY: Would you propose that the man who actually does the field work, and upon whom lies the responsibility of determining the lot lines when he is out on the ground, should become a licensed surveyor?

MR. RICKER: In case there is a mistake made in a survey and a building should extend, say, over on to another lot, owing to inaccuracy in locating the lot lines, the owner of the adjacent land on which the building has encroached may require that building to be removed so far as it covers his land. In that case the original surveyor who sent out the man would be responsible in damages to the man who owned the building, and if he had any property, damages could be collected from him.

MR. FEENEY: The point is this: Surveyors who have more business than they are able to handle themselves employ men to go out and do the field work. There is no question but the man who runs the office would be held responsible for the work, but do you not believe that if the man in charge of the party were required to take out a license, that would have a tendency to lessen those errors and mistakes?

MR. RICKER: I do. I may say further, that in the architect's license law we have one great difficulty in regard to our practice we have "patent medicine architects," who will furnish plans for houses with full specifications and estimates of cost at $5 apiece. They are not allowed to practice in this State, but have their offices in States without a license law.

In order to meet another possible source of opposition to the license law, it was judged necessary that contractors should be allowed to furnish their own plans and specifications, and be allowed to erect buildings from them; the responsibility for defective construction would be then fixed on the contractor. This frequently occurs in places where there is no general building law, and where a contractor will be employed as architect by the owner because he will agree to furnish the plans free of charge. The owner sometimes takes those plans to other contractors, for bids, and lets the job to another contractor. That, under the law, makes the author of the plans an architect practicing without a license, and puts him in the power of the board. In Chicago, this competition by contractors was cut off by a city ordinance which requires that before the issue of a building permit, the seal of a licensed architect must be on the set of drawings and specifications presented for the permit. Occasionally a licensed architect is approached by a contractor who has a set of plans and specifications already prepared, suggesting he act as consulting architect, examine these plans and specifications and attach his seal to them. In other words, he pays him a fee for putting on his seal. The board has revoked licenses in several cases for this practice.

MR. GREELEY: Whether the assistant surveyor who goes out in the field shall be a licensed man or not is entirely immaterial. It may be well to have him so, although the best bond is responsibility of his employer. I cannot afford to send out men who will make a mistake for which I shall have to pay. The real question is, who shall sign the certificate of any given plat? If I send out my assistant with instructions, he reports to me, I look over his work, satisfy myself, and become responsible for it. I am the man to sign the certificates for that plat, and not the man whom I sent out.

MR. RICKER: The architect's license law defines a building as a structure having foundations, walls and roof. A reservoir with roof 90 ft. diameter is undoubtedly an architectural structure. A case occurred concerning large elevators with cylindrical steel bins. The board decided that such a structure had foundations and walls, but did not have a roof within the meaning of the law; therefore an engineer could build a structure of that character without interfering with the law, without requiring a license. A covered reservoir would certainly be under the law, but not any structure that is entirely underground.

MR. JOHN F. LAFFERTY, of Martinsville, (by letter): I commenced using the compass and engineering instruments 63 years ago. The laws should be changed to provide that the surveyor should be appointed; or if elected by the people he should be examined by a competent board, appointed by the Governor or the Legislature, and if he is not qualified he should not be allowed to run lines or make a record on the books. I know of a surveyor who does not know the difference between an acute angle and an obtuse angle, and thinks the variation of the magnetic meridian is all nonsense, intended to mislead the ignorant land owner. Another surveyor knew nothing of the principles of geometry, algebra or logarithms, and could not see any use for the traverse table. The consequence is that we have sometimes three or four stones some distance apart marking the same corner and causing many bitter neighborhood quarrels and litigations.

DRAINAGE IN WESTERN IOWA.

BY J. G. MELLUISH (MEMBER).

The new drainage laws in effect May 3, 1904, framed by the Iowa Legislature, have created the greatest activity in those counties in which drainage was so much demanded. In brief this new statute provides that a petition signed by one or more land owners interested shall be filed with the county auditor; the district to be improved by drainage must be designated in the petition, together with the termini and general course of the proposed improvement. Accompanying the petition is a bond sufficient to cover the costs in case the petition is refused by the Board of Supervisors. On filing the petition and bond, the Board appoints a drainage engineer to survey and report (with estimates and recommendations) upon a drainage system for the lands named in the petition. The supervisors consider the engineer's survey and report, and if they consider them favorably, they notify all owners of property to be affected of their decision, and appoint a time for hearing their claims. Claims for damages must be adjusted by a disinterested jury of three freeholders before proceeding farther. Damages having been settled, the Board declares the district established. The Board divides the improvement into sections, and advertises and lets the work. An engineer of construction is appointed who is required to give a bond for the faithful performance of his duties. Thereafter the administration of the improvement rests with the engineer.

The status of the construction engineer under this statute is one which demands the highest engineering skill in drainage, complete business ability in dealing with contractors of material and labor directly, absolute integrity, and experience both in methods and in administration. A bond sufficient to cover the liability for an engineer fulfilling the duties imposed upon him should of necessity be a high one, (at least in amount equal to 25% of the aggregate contract price of work to be done under his charge). It remains to be seen how many of our drainage engineers will be able to furnish such a bond. Individual bondsmen are not easy to obtain and surety companies will find few engineers able to schedule enough property to warrant them in writing an indemnifying bond.

Four very important and praiseworthy features of this new Iowa drainage law are: (1) the one signature petition; (2) the completeness required in the preliminary survey, no change being permitted after organization of districts except by a repetition of he whole preliminary process; (3) the centralization of responsibility in the engineer of construction; (4) the alternative of payment of assessments by property owners at their election in either improvement certificates or bonds.

Because of the unconstitutionality of the drainage act which the present law replaced, it seemed desirable to ask the Supreme Court of the State for an opinion upon this new statute before any liability should be incurred by the several counties in the construction of the large drainage works now planned. A test case, therefore, from Monona County, in which other counties interested have joined, is now before the Court. The fate of drainage in Iowa hangs by this decision.

The State of Iowa is substantially a rectangle, whose length is a little over 300 miles, and breadth north and south 200 miles, embracing an area of 55,000 miles, or 35,250,000 acres. Its topography is remarkable by reason of its continuity; by its absence of forest or timber tracts except as such occur along the margins of the larger streams, and by its preponderance of prairie land. There are few lakes within the State and these are small in area, Spirit Lake and Okiiboji Lake in Dickinson County being the largest. Other lakes are, Clear Lake in Cerro Gordo County; Twin Lakes in Calhoun County; Swan Lake in Emmett County; Swan Lake in Pocahontas County; Storm Lake, Buena Vista County; Wall Lake, Sac County, etc. Many of these, if not all, will ultimately be reclaimed for agricultural uses.

The drainage of Iowa is effected by the Missouri and Mississippi rivers. The ridge dividing their watersheds, in the form of a crescent which is concave toward the east, begins at a point on the Minnesota line, about two-thirds the length of the State from the Mississippi river, curves gently south and southeasterly to the Missouri line at a point about midway across the State. The elevation of the northern end of this dividing ridge is 1694 ft. above sea level; of the southern end, is 1020 ft. above sea level; the average progressive change of elevation being approximately 2¼ ft. per mile. The lowest elevation in the State is low water at Keokuk, which is 444 ft. above sea level. West of this ridge the natural streams flow southwesterly to the Missouri river; east of it the natural streams flow southeasterly into the Mississippi river.

West flowing streams, or Missouri watershed: Big Sioux, Floyd, Rock, Little Sioux, Maple, Boyer, Nishnabotana, Nodaway, Platte, Grand, Chariton.

East flowing streams, or Mississippi watershed: Upper Iowa, Turkey, Maquaketa, Wapsipinicon, Cedar, Skunk, Raccoon, Boone, Des Moines, and its branches.

The gradients of some of these streams are approximately as follows:

	Fall in feet per mile.
Mississippi, Lansing to the Missouri river	0.5
Missouri, Sioux City to Council Bluffs	1.0
Des Moines, upper three-fourths	2.4
Des Moines, lower one-fourth	1.9
Raccoon, junction near Van Meter to outlet	1.9
Skunk, Colfax to Oakland	2.2
Skunk, Oakland to outlet	1.5
Iowa, Iowa Falls to Iowa City	3.1
Iowa, Iowa City to outlet	2.4
Cedar, State line to Cedar Falls	3.6
Cedar, Cedar Falls to Moscow	2.4
Wapsipinicon, Independence to outlet	2.8
Nishnabotana, upper 20 miles	7.0
Nishnabotana, Riverton to outlet	1.0
Nishnabotana, average for entire length	4.7
Little Sioux, Cherokee to Smithland	2.5
Little Sioux, Smithland to outlet	0.5

It will be seen from the above that there are no vexatious problems presented in drainage engineering in Iowa on account of flat gradients.

It is upon this dividing ridge that the largest upland drainage improvements have been planned. A belt of land averaging about 60 miles east and west within this divide, beginning at the Minnesota line and extending southward into Union County, dotted with swampy, marsh areas, and prairie sloughs is sought to be reclaimed. Surveys which had been made in 1903 in some counties under the former drainage act have been used as far as possible in the work under the present law. In Emmett County and Kossuth County, former surveys have been readopted and considerable new work has been laid out by Mr. A. J. Lilley, County Surveyor of Kossuth County. A joint drainage district between Kossuth and Emmett Counties which will effect the drainage of Mud Creek has been organized. In Kossuth County the plan has been to survey and report upon not only the main drainage, but upon lateral drainage systems. This has necessitated a good deal of time to be put upon the preliminary work of a single district, and by so doing fewer main districts have been established in this county than might have been expected from the large area of the county and the extreme need therein of immediate drainage. Prof. W. H. Stevenson, of the Iowa State College, has reported 36% of land partially unproductive in 1903 in Kossuth County. The principal district which has been established in Kossuth County and which will soon be let, is the district known as No. 3.

In Humboldt County three main districts and numerous minor districts and lateral districts and several small joint districts with Webster County have been planned also. Land partially unproductive has been reported for Humboldt County in 1903 as 26%. In Pocahontas County surveys were begun early in May, 1904, for improved drainage on five large districts, namely, the Big Cedar, West Lizard, South Lizard, Tishenbanner and Smith districts. The Big Cedar has a total length of main channel of about 27 miles, beginning at a point near the Calhoun County line southwest of Fonda, and extending northward to a point near the north line of the County, above the town of Laurens. Its watershed is approximately 4 miles wide throughout; at the northern terminus it will effect the drainage of Swan Lake and Muskrat Lake, recently reported upon by Prof. L. E. Ashbaugh for the State of Iowa as proper to be reclaimed. The survey of the Little Cedar which joins the Big Cedar 1½ miles north of Fonda will proceed in the spring. This stream has its source in Clay County, flows through Buena Vista County, enters Pocahontas County west of Laurens, flows southward paralleling the west line of Pocahontas County and one mile distant therefrom. On account of the mutual service which the improvement of the Little Cedar would afford Buena Vista and Pocahontas Counties it is expected that the petition from Pocahontas County will be supplemented by a joint petition including Buena Vista County. While the cross-sections for the Big Cedar, upon which the surveys were recently completed, have

A TYPICAL SWAMP IN POCAHONTAS COUNTY, IOWA.

not been worked out thoroughly, the base of the new channel will be approximately 45 ft.; depth, 9 ft.; side slopes, 1.6 to 1 ft., for the lowest section, and a base of 10 ft. for the upper section.

The South Lizard District begins near the Calhoun County line, northeast of Manson, and extends northwesterly about 20 miles in a direct line; its watershed covers 48,000 acres. Excepting for the lower three miles of its course the South Lizard Creek is hardly more than a prairie creek without banks or channel, grazed over by cattle during the dry season, and yet this part of the stream receives the flood water and drainage from 30,000 acres. The channel prepared for this stream will have a base of 40 ft.; depth of 8 ft.; side slopes, 1.6 to 1 at the lower end, and a base of 6 ft. at the upper terminus. The gradients will average 3 ft. per mile, being greater, of course, at the lower end than at the upper end. The West Lizard District embraces 34,000 acres in its watershed; will have a channel with base of 32 ft. in width at outlet; depth 7.5 ft.; side slopes, 1.6 to 1; the upper section will have a base of 26 ft.

Other districts on which surveys and reports have been completed now under contract or ready to be let are the Welander, Albert Smith and Tishenbanner, each of which will cost from $10,000 to $15,000. The Tishenbanner District presents some interesting features. Its watershed comprises 2,000 acres; of which 40% has been unprofitable for cultivation during the past two years. For several years repeated attempts at reclaiming wet lands within this district have been made by the construction of "sinks." The usual method of making them being to drive a 6-in. pipe down into the limestone, where if successful, a fault in the strata is found through which the drainage water seeps and wastes away. The writer knows of but one successful venture in the vicinity of this district, most of the ventures having resulted in "dry holes." Enough money was expended in seeking underground drainage by "sinks" to have thoroughly drained a large portion of the entire area. After the fascination of gambling for a drainage deep in the earth had been exhausted, the people interested drew up a petition for drainage under the present law. Accordingly an underdrainage system, having 24-in. pipe for its outlet was designed. The outlet is into a stone quarry from which the water wastes through numerous faults in the rock.

In Calhoun County, surveys have been in progress during the past year upon several drainage districts of moderate size. Drainage has not been agitated in this county so enthusiastically as in adjoining counties (although none the less needed), because perhaps of the failure of a dredged ditch constructed a few years ago in the northern part of the county. Failure could have readily been predicted by any competent drainage engineer at the time the work was in progress, and the result indicates the extent to which a good cause is injured by a single case of incompetence. As the result, although unfortunate, was unnecessary, it is to be hoped that the progressive land owners and farmers of Calhoun County will take courage and push the reclamation of lands within their county to a successful completion.

In Hamilton County several drainage districts have been organized, some of which are joint districts with other counties. The Supervisors of this County are waiting the decision upon the validity of the law before proceeding to let any contracts. In Webster County, besides joint districts with adjoining counties, districts 2, 3, 4 and 5 have been organized. District No. 2 embraces an area of 6,200 acres, and the length of the proposed channel is 7.42 miles. District No. 3 embraces an area of 5,500 acres and its proposed channel will be 7 miles in length. District No. 4 embraces an area of 2,800 acres and its proposed channel will be 33⅓ miles long. District No. 5 embraces an area of 22,630 acres and its proposed channel is 33⅔ miles long. The preliminary work, both clerical and surveys, have been very thoroughly done in this county and may well be followed as a pattern by other counties.

NEW DRAINAGE CHANNEL IN CARROLL COUNTY, IOWA.

In Carroll County, a channel has been constructed which is the first to be completed by a new type of steel bucket excavator. This ditch was constructed with a base of 16 ft.; side slopes, 1 to 1; and depth of 7 ft. The berm is nowhere less than 8 ft., even in the deepest cuttings. Owing to the progression of the excavator up-stream the average depth of the channel as now completed is only 6.6 ft., but the perfection of the work done, true side slopes, even smooth bottom and uniform cross-section throughout commends this method of excavation wherever it may be successfully adapted, to the attention of every thoughtful, progressive drainage engineer.

As to the drainage work in the lowland river districts in western Iowa, there have been two improvements planned which promise large results, both in the area of reclamation and affording better drainage. The channel constructed in 1903, in southern Woodbury County, is to be continued through Monona and Harrison counties and will deliver directly into the Missouri river, instead of into the main channel of the Little Sioux, its natural outlet. By thus diverting the waters of the West Fork (branch of the Little Sioux) from the Little Sioux river and distributing the same into the Missouri, it will afford an adequate drainage outlet for the territory lying north of the outlet and will relieve the main channel of the Little Sioux from the waters discharging from half a million acres of land.

The Nishnabotana River improvement in Fremont County, Iowa and Atchinson County, Missouri, is designed to afford relief to the lower 20 miles of the bottom land and an improved outlet for the upland, aggregating nearly two million acres. The completion of the proposed channel will be a notable improvement for Fremont County. The improvement of Mule Slough in Harrison County and lateral ditches thereto has been planned; there will be approximately 122,000 cu. yds. of excavation in this district. The county ditch, aggregating 40,000 cu. yds.; also in Harrison County, is ready to be let pending the Supreme Court decision.

It will thus be seen that the greatest activity in drainage work is in those counties whose relative elevation is the highest in the state, yet whose percentage of area of waste land is largest. Prof. W. H. Stevenson, of the Iowa State College, Ames, Ia., from a careful statistical investigation of the condition of drainage in Iowa, has arrived at the following results, which though they may not express precise and exact conditions for every Iowa county, are sufficiently accurate as respects the entire State to merit careful consideration. They are as follows:

1	Average size, Iowa farm, in acres	359
2	Per cent. partially unproductive, 1903	16.2
3	Per cent. wholly unproductive, 1903	6.4
4	Per cent. of land in pasture, because too wet to cultivate	9.9
5	Per cent. of land subject to overflow	6.8
6	Per cent. of farms without adequate outlet	41.7
7	Per cent. of farms susceptible of benefits by drainage	27.1
8	Per cent. of partially unproductive land in township	11.8
9	Number of acres partially unproductive	4,062,355
10	Annual loss at $5 per acre of same	$20,311,775
11	Profitable limit of expenditure, for drainage	$406,235,500
12	Cost of drainage at $25 per acre	$101,558,875
13	Increase in property value in the county	$304,676,625

Prof. Stevenson remarks * that $25 per acre is a liberal estimate for the cost of reclaiming the partially unproductive land per acre for the entire State; and that "it is believed that this amount is

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* Bulletin 78, Exp. Station.

somewhat higher than the actual conditions warrant." From a review of the cost of reclamation in Illinois where the highest charge per acre was $16 (which included a pumping system in addition to the gravity channels), and the lowest was 75 cts., the writer would place the fair average cost of reclamation for the State of Iowa at $9 per acre. Assuming the cost of drainage at $9, items (12) and (13) above would read $36,561,195, and $369,674,305 respectively.

A few points which are suggested from the writer's observations and studies in drainage work in Iowa are the following:

(1) That a great deal of the work which has been done during the past year and is still being done is of little permanent value. For example, hundreds of miles of what is known as "capstan plow drains" have been made, whose effective depth is less than 3 ft. These are being used as outlets for tile drainage and of course while as such they may be efficient for a few special seasons, yet it will be a matter of but short duration until through silting and bursting by frost the tile drains become worthless. Drainage engineers should condemn the practice of using or recommending the capstan ditch as an outlet for tile underdrainage. Capstan ditches are of temporary utility at best and are effective as superficial drains only for the economical and rapid removal of shallow areas of water.

(2) There is a lack of appreciation of the value of depth in the design of open and closed drains; the practice is to make them too shallow, an average of four feet and even less being common as main outlets for districts whose drainage areas are from three to five miles in width. Drainage engineers who refrain from making their channels of ample cross-section because of fear of high initial cost from large yardage should study the history of drainage in Ohio, Indiana and Illinois, and learn that it is bad economy and worse engineering to design insufficient channels.

(3) A source of trouble which must be provided for in Iowa underdrainage is the muskrat, who finds a large tile drain a most congenial home after his swamp house has been taken from him. Protection in this particular can be effected in several ways and should not be omitted.

(4) The size of underdrains and the intervals at which they are laid is a matter which has not been given the attention which it should have in Iowa. Taking the soils of Pocahontas and Kossuth Counties as examples, it will be found the average effective diameter of the soil grain is 0.045 m.m., while for McLean County, Illinois, it is 0.031 m. m. Under similar conditions therefore, the conductivity, or rate of flow through a section of each, would be approximately in proportion to the squares of their diameters, or as 0.002025 is to 0.009610; that is to say, the Pocahontas County soil would permit nearly five times the quantity to flow in a given time than the McLean County soil; which when practically applied means that underdrains can be spaced at five times greater intervals in Pocahontas County than in McLean County, Illinois. At present there is little to be

feared from too close spacing of underdrains, but it should be borne in mind as underdrainage develops that in the loose, rich, damp soil of many Iowa counties, if aeration proceeds too rapidly, the excessive rate of nitrification of the humus into valuable nitrates will rapidly leach away the soil and thus underdrainage may be a foe rather than a friend of good husbandry.

(5) The writer questions very much the practice of dredging small channels for large watersheds and depending upon the scour to enlarge them later. The enlargement by erosion requires time to become effective and of course this method does not afford immediate drainage. It removes a large amount of soil which should be retained at or near its location. The removal of soil by erosion means a redistribution of it in another channel or area and simply enlarges the problem of preparing and maintaining main outlets for the tributaries. The argument that it is a cheap way to obtain an improved channel for one certain section of country, may be true for the time being, but it is certain that it is not a just method of securing drainage, any more than throwing garbage into the street or on one's neighbor's property, is a fair method of ridding one's self of a nuisance. It is also a question whether as time elapses and the Mississippi river and its tributaries, receiving the mud-laden discharge from its watershed, gradually filling, the government will not have to repair these river outlets by an enormous expenditure of money. In that case the tax imposed for so doing will find its incidence practically if not entirely on those responsible for the silting. This practice of securing drainage by the scour of a small artificial channel is so common among drainage engineers that to the writer it seems an abuse of intercounty and interstate rights, and it should be prohibited by law.

(6) On account of the open texture of the soil of Iowa, particularly such as is found in northwestern Iowa, the unprotected, treeless prairie, and the prevalence of high winds, the writer has thought it expedient to protect the waste banks from being drifted back into the excavated channel in the work under his charge. This has been effected: 1, by providing somewhat greater berms than is usual; 2, by insisting upon a certain maximum height of the spoil bank; 3, by scattering or distributing the waste bank from unusual deep cuttings as soon as practicable; and 4, by sowing the spoil bank to rye and blue grass.

Summarizing the drainage conditions in western Iowa as a whole, it may be said that should the Iowa Supreme Court uphold the present drainage statute, an activity such as Iowa has never experienced will be inaugurated for the dredging of drainage channels, for repairing river courses, for tile underdrainage, and for the manufacture of drain pipe and other drainage supplies. The result of this promised activity in reclamation when begun will be the incoming of investors in land, of manufactures, and increased wealth and prosperity for the whole State.

HOW TILE DRAINAGE IMPROVES A SOIL.

BY A. B. ALEXANDER (MEMBER).

Draining a soil consists in removing either naturally or artificially the surplus water from the soil; hence a drained soil is one which is moist but not saturated with water. A perfectly dry soil is dead. It is worthless for producing plants, except those which derive their nutriment from the atmosphere alone. A soil that is completely saturated with water will produce nothing but aquatic plants, and hence is worthless for farm products. The nutriment which plants take from the soil is in liquid form only, it having been prepared by chemical action brought about by the union of heat and moisture with the elements present. An excess of moisture reduces the temperature, excludes the air, and dilutes the plant food, thus retarding or entirely stopping the growth of the plant as effectually as is done when the soil is too dry. Therefore, in order for the soil to produce to its fullest extent, it must be supplied with moisture, or have a superabundance removed from it, as the case may be. In central Illinois the latter is usually the case, and in order to remove this excess of moisture, there is no better way yet known than through tile drains, properly laid beneath the surface.

Some of the best drained soils are so by nature. They are underlaid with a stratum of material which gives free egress to surplus water and is composed of elements which respond readily to the efforts of the cultivator. On the other hand, there are soils just as rich in natural fertility, but unproductive, because under all ordinary circumstances they contain too much water. Their natural location is such that they are saturated beyond the point required for profitable plant growth. Such soils should be artificially drained. This only will develop their fertility and make them profitable. Whether the excess of soil water comes from rainfall direct, or from seepage of soils which occupy a higher level, the surplus must be removed before the soil will be in proper condition for plant growth. Underdrainage is far better than surface drainage, for the reason that surface drainage removes the water from the land before it enters the soil, or at least before it penetrates farther than the surface layer, while underdrainage removes surplus water by taking it downward through the soil and away from it by means of natural or artificial channels within the soil. Sufficient surface drainage should be provided to insure the completion of the work of underdrainage. The advantage of removing the surface water down through the soil is to retain everything, not permitting the finest and most fertile parts to be carried off with every considerable rainfall. Any manure or other fertilizer deposited upon the soil is carried into it with the water as it percolates downward from the surface, and so becomes thoroughly incorporated with the soil.

Rain and snow water are fertilizers, enriching the soil by dissolving the crude soil material for the nutrition of plant life. Soil that is underdrained is ready at all times during the growing season for the growth of plants, such growth not being hindered by stagnant water or saturated soil. The frost goes out earlier in the spring, so that the planting season opens one or two weeks earlier than in the case of undrained soils. The soil is made more porous, open and friable, roots penetrate deeper than they do into undrained soils. The effects of drouth are diminished, owing to the enlarged and deepened soil bed, and to the perfect condition of the surface for preventing undue evaporation of moisture.

A certain degree of soil ventilation has been found necessary to bring lands to their highest state of productiveness. When the level of the ground water is lowered the roots of plants penetrate more deeply into the soil, and as they die and decay leave a network of channels extending to the surface through which air circulates, forming ventilating shafts. The water having been removed the pores in the soil fill with air which carries with it any fertilizing gases it contains and supplies nutriment to the roots of plants. Hence, the change that has been wrought by taking the water out of the soil and allowing the air to circulate is a very important factor in keeping up the productiveness of soils. In other words, well drained soils do not become exhausted as soon as undrained ones.

A drained soil also resists drouth better than one that is not drained for the reason that it is capable of retaining a greater amount of capillary water, allowing the plant to draw moisture from a greater depth. The experience of farmers who have drained their land has been in every instance in favor of underdrainage in time of drought. One proof of this is that the best part of the crop always grows over or along the lines of the underdrains.

Another benefit derived from proper drainage is that soils do not heave to such an extent as to injure plants. When soils which are saturated with water freeze, the water expands and as a result the surface of the soil is raised, carrying with it plant-roots which are not anchored below the frost line. A thaw melts the ice, and the soil under ordinary conditions settles back to its original position but plants with shallow rooting remain in their raised position.

Alternate freezing and thawing which take place in some localities several times during the winter, not infrequently leave the roots of clover, wheat and rye partially or wholly out of the ground. Often during the winter season whole fields of clover and wheat have been ruined in this way and meadows of timothy have been greatly injured during one winter. If the soil is not saturated, that is if there is air space in it and the moisture has sufficient space for expansion when it freezes without materially disarranging the soil grains, no such injurious effects as have been named will follow.

The question is often asked, "Will it pay to underdrain clay soils?" Such soils are characterized by extreme fineness of texture and by great retentive power for water. Their particles are the finest of all soil particles, hence in order to make a soil of this kind productive it is necessary to remove the water out of the soil and allow the air to get in. The only way to accomplish this is through a system of underground drains. While the yield per acre on the clay soil would not be as great as on black soil, yet the proportional increase of thorough underground drainage of clay soil, will be as great per acre as that of the black soil. Heavy clay soils require more labor and more tile to do thorough work, but the added profit realized from the increased yield of products will return to the owner the cost of underdrainage in two or three years at most. After that the increased yield is an added gain each year.

The efficiency of draining any soil depends largely upon the location and construction of the drains. The outlet should be well protected and kept in good repair at all times. The ditches should be straight where possible and excavated to a true grade; good tile only should be used and great care should be taken to lay them in the trenches properly.

THE INLET SWAMP DRAINAGE DISTRICT.

BY A. M. SHAW (DIXON, ILL).

The Inlet Swamp Drainage District comprises about 30,000 acres of swamp and low land in the eastern central part of Lee County, Ill. About three-fourths of this acreage was originally included in the Inlet Swamp. This tract, or nearly all of it, had a slight fall toward the old village of Inlet where the water converged and formed the beginning of the Green River. A considerable channel had been worn through the limestone rock which crops out at Inlet, but this was neither of sufficient depth nor width to furnish a sufficient outlet. I have been unable to find much satisfactory evidence as to the geological history of this swamp though all evidence available goes to show that the territory was at one time well drained, but through some action of nature, the drainage has been obstructed. This was probably done either by an upheaval of the rock ridge at Inlet or by a subsidence of the swamp land, the latter appearing the more probable.

This section of the country was subjected to glacial action, glacial deposits being in evidence over the entire swamp. Fortunately for the drainage enterprises, the deposits are almost entirely of coarse sand or gravel, very few boulders being found. Occasionally limestone rocks are encountered along the northeastern portion of the swamp, these evidently coming from the limestone ridge that forms the divide between the Inlet Swamp Drainage District and the Brush Grove Drainage District. Trunks of enormous black walnut trees were dug out at depths of 10 or 11 ft. at various points. These logs were sufficiently well preserved to require blasting before they could be removed by the dredges. A typical section of the upper soils would show 15 to 24 ins. of black vegetable loam, 36 ins. of yellow or yellow and blue clay, and under this water laid sand and gravel. The natural fall of the surface varies from 1 ft. in three miles near Inlet to 10 ft. to the mile at the eastern extremity of the district.

The early history of the drainage projects in this swamp is identical with that of many similar projects. Small ditches were dug by hand or with teams, but lack of proper construction or location or an insufficient outlet or possibly a combination of all these defeated the plan. Later, larger ditches were dug in the same way and with the same result. It was not until about 1886 that any serious effort was made to organize all of the interests involved for the purpose of establishing a complete drainage system. Previous to this date, a few of the land holders in the swamp started a movement for better drainage but they were defeated by the mill owners along the Green River, by promoters of game preserve projects, and by the ignorance and apathy of other landowners.

The order creating the district was entered Aug. 5, 1887. Mr. A. E. Rutledge, of Rockford, was the first engineer employed by the commissioners and he remained as engineer for the district until the completion of the original construction work. The boundaries of the district and the general arrangement of the ditches remain about as they were originally established though the size and depth of the more important ditches, as recommended by the engineer, were arbitrarily reduced by the action of the Commissioners or by the court. As an example of this action, it was recommended that the main ditch should have a bottom of 50 ft. and it was to be extended to Binghampton where two dams were to be removed. This bottom width was reduced to about 18 ft. and the excavation stopped at a point about two miles above Binghampton, the dams remaining undisturbed. The widths and of course the fall of the more important tributaries were correspondingly decreased. In justice to Mr. Rutledge, these facts should be borne in mind, otherwise the matter following might be considered as a criticism of his work, an action which the facts certainly would not justify.

In a very short time it became evident that the outlet was not sufficient to give the relief sought and various efforts were made to improve the conditions. Work amounting to over $10,000 was done at one time by private enterprise with a view to increasing the width of the rock cut at Inlet. In 1896-97, the main ditch was enlarged and extended to Binghampton. It now has a bottom width of about 30 ft, and is 5½ miles in length. It has a fall of a trifle over 1 ft. to the mile. The following figures are approximately correct:

Area of district	30,000 acres
Taxable value of lands in 1886	$183,769
Estimated sale value of lands in 1886	300,000
Estimated sale value of lands in 1905	2,100,000
(Above is exclusive of improvements.)	
Increase in land values	1,800,000
Cost of drainage work to date	197,000
Average cost of drainage per acre	$6.57
Maximum cost of drainage per acre	10.50
Length of main outlet ditch	5½ miles
Total of all ditches	57 miles

The above figures apply only to the work done by the drainage district. A number of small ditches have been dug by private enterprise and a large amount of tile has been laid. Practically all of the land of the district must be provided with artificial sub-drainage before it can be cultivated to the best advantage. Owing to the varying depths of the porous sub-soil in different parts of the district, there is a wide variation in the cost per acre for tiling, but it is probable that $5 would be a fair estimate of the average cost.

The principal difficulties with which the district now has to contend are as follows: 1, excessive fall in the upper reaches of tributaries (amounting in some cases to 10 ft. per mile), causing erosion of banks, cutting of new channels and destruction of crops and damage of fields from deposits of sand and gravel at times of overflow. 2, Lack of fall in the main ditch and lower tributaries impeding the flow and causing deposits of sediment. 3, Insufficient width of lower tributaries and main outlet, further checking the flow and causing backwater and overflow of the lower portions of the swamp during wet seasons. 4, Growths of willows along and in the ditches. In some localities, these have done considerable damage by causing the ditches to fill. 5, Caving of banks and waste banks. This caving material forms bars which either retard the flow or deflect the current so that it attacks the opposite banks. The first mentioned problem, due to excessive fall, affects only a limited area, but is demanding prompt attention, as the ditches in this portion of the swamp are cut down into the gravel subsoil which washes out very fast. Willow poles and matting will doubtless be sufficient to prevent the cutting of the banks though it may be necessary to do a small amount of rip rapping.

The lack of fall is, as in many drainage projects, the most serious obstacle and one which cannot be entirely overcome. In most districts there is some point where the speed of the current will be slackened; in the Inlet district this unfortunately comes near the point of convergence of several of the large tributaries. A ditch of sufficient cross-sectional area to carry away the water as fast as it can be delivered by these ever increasing tributaries would be of enormous size, probably much larger than the landowners would be willing to pay for. A plan which is now being considered for giving greater carrying capacity to the main ditch is a combination of enlarging and deepening the main channel a reasonable amount and the installation of a complete system of levees along the lower portion of all tributaries. These levees are to be set far enough back to form a waterway that will be sufficient to prevent overflow during the heaviest storms. They should be extended in unbroken lines and their maintenance should be under the direction of the drainage commissioners.

The willow question has received little attention until very recently, but it has here been discovered to be of considerable importance. In many cases, the willows planted along the edges of ditches have spread to such an extent as to greatly restrict the channel while branches dropping from them have floated in the stream for a distance and finally become lodged and taken root in the bed of the stream. In one of our larger ditches a willow thicket was removed last season that extended for nearly a half a mile, covering the entire bottom of the ditch. Last year, the court authorized an annual appropriation for establishing a regular patrol of the district, and the removal of willow brush and small willow trees from the ditches will be one of the duties of this patrol. A vigorous campaign against the willow hedges has been begun by the commissioners and it is now receiving quite general assistance from the landowners.

Caving banks are a continual trouble. It would be difficult to find a ditch dug more than five years ago, where the banks are still in their original position on both sides of the ditch. I do not recall seeing a set of specifications for drainage ditches that did not call for a slope of at least 1 to 1, nor do I recall seeing a single piece of work done in the ordinary way, with a dipper dredge, that had such a slope. Fairly good slopes are dug by railway steam shovels in cuts not exceeding 10 or 12 ft. in depth. Why cannot the same result be obtained in drainage ditches? I am afraid that the extreme persuasive powers of contractors have something to do with this. How often has the generous contractor offered to take out even more than the required yardage without extra compensation, if he may be allowed to dig his ditch with vertical banks. No great study is necessary to find the results, which will be frequent caving of the banks, restriction of the stream at that point, or worse yet, the transportation of the material to some point where the carrying capacity of the ditch is already overtaxed and the formation of a bar where the current is checked.

Little material encountered in drainage work will stand at a slope of less than 1 to 1 if subjected to the action of weather and running water, and most material requires a slope of 1½ or 2 to 1 for a permanent slope. Railway men demonstrated this years ago, while those in charge of projects more closely resembling drainage work (such as levees and canals) have adopted slopes of 2 or 3 to 1. The following is my ideal of a six-foot drainage ditch requiring a cross-sectional area of 75 sq. ft. for ordinary flood water and twice that for maximum flood water: Depth, 6 ft.; bottom width, 1 ft.; slopes 2 to 1; top width, 25 ft.; berm, 8 ft. Waste banks to be dressed down to a height of 2½ ft. and sodded. The waste banks and berm could then be used as pasture or hay land, but should never be cultivated.

Various methods were employed in the construction of the smaller ditches, some of them being dug by hand or by teams and scrapers but the bulk of the work was done by dipper dredges on barges. The contracts for the heavy work were let at 10 to 11 cts. for earth and 80 cts for solid rock.

I have been operating for the past season an excavating machine of a comparatively new type. It is a land machine known as the Jacobs steel excavator. The machine spans the ditch, the digging being done by two buckets which travel across the line of the ditch on adjustable runaways or guides. My machine, as adjusted at present, will dig a ditch 8½ ft. deep with a 6 ft. bottom and slopes of 1½ to 1. It can be adjusted to any slope or width up to a top width of 33 ft. The buckets take out a cut of 4 ft. in width at each move. The feed of the buckets is controlled by four screws which are geared to the engine by link belts. While one bucket is traveling up the runway and dumping, the guides are lowered by the screws so that a full cutting is taken by the returning bucket. The work last season was the construction of a ditch with 6 ft. bottom and slopes of 1½ to 1; average depth, 5 ft. The route followed an old ditch for a considerable distance, which made it necessary to do some blocking. The yardage was of course reduced by this old ditch.

Under these conditions, the actual cost of the work, including running repairs and all other incidental expenses, was practically 7 cts. per cu. yd. Under more favorable conditions and with heavier work, this price could be very greatly reduced.

The principal advantages of this excavator are: Perfectly uniform bottom and sides, with banks at any desired slope. Clean and undisturbed berms of any width. Even distribution of waste banks, with possibility of wasting entirely on one side when local conditions make this desirable. Simplicity and economy of operation, the engineman being the only skilled laborer required. Ease and economy of transportation, one flat car being sufficient for the transportation of the largest machines. Possibility of moving the excavator short distances on its own wheels (when moving from one job to another) without dismantling. The limitations of this excavator are: any kind of bed rock, genuine hard pan or heavy frost. Large stumps cannot be pulled by it without blasting. The work cannot be done economically where there is much water above the surface of the ground. This last applies to the machine as it is manufactured at present though I can see no reason why the same style of machinery would not work successfully on a boat.

REPORT OF THE COMMITTEE ON DRAINAGE.

From 1894 to 1901, inclusive, was a period of very low rainfall throughout the Mississippi valley and especially so throughout the State of Illinois. Prior to that time landowners in Illinois had been very active in carrying out large drainage schemes by organizing drainage districts and also detail drainage, both open and tiling. A large amount of work accomplished prior to that time and a succession of dry years led the farmers of Illinois to believe that thorough drainage had been accomplished and in many localities that the work had been overdone. The wet years of 1902, 1903 and 1904 resulting in a large reduction in the productiveness of flat and partially drained lands, has set many farmers throughout the state actively at work to improve the drainage of their lands and has increased the volume of drainage business very greatly.

A prominent form of drainage work which is now in progress in Illinois is the straightening and deepening of the smaller streams and rivers and leveling against overflow in the Illinois River valley and some of the other principal rivers. Among some of the important works now under progress or completed is the straightening of the Green River in Henry and Bureau counties at an estimated cost of nearly $1,000,000; the straightening for 14 miles of Salt Creek in Mason and Menard counties, and the straightening of 12 miles of the Sangamon River in Mason County. The Green River improvement is reported as about ready for receiving bids and the other two are under consideration. The Cache River straightening was the subject of a paper read to this Society a year ago. A number of drainage and levee districts have been projected or organized for reclaiming from overflow the lands in the Illinois River bottom. Of those which were constructed prior to 1902 the condition of three districts is fairly well known to your Committee. First, the Pekin and La Marsh Drainage District containing about 2,000 acres, was organized, levees and ditches constructed and pumping plant installed about 16 years ago. The Lacey Drainage and Levee District in Fulton County, opposite Havana, was constructed soon after, and pumping plant was installed about the year 1900. The Coal Creek Drainage and Levee District, opposite Beardstown, was organized and levee completed about eight years ago. The interior ditches were constructed and pumping plant installed about the same time. In 1902 the levee at the upper end of both the Pekin and La Marsh Drainage and Levee District and the Lacey Drainage and Levee District broke and the lands within were flooded. The Pekin and La Marsh Drainage District has not yet been repaired and during the high waters of 1902, 1903 and 1904, the wave action upon the inside of levee practically destroyed it. During the year of 1903 the Lacey levee was repaired, but the flood of 1904 broke over the levee again and practically submerged the entire levee for several miles along the upstream side of the district. Both of these districts are seeking authority from the courts to raise additional funds to put them in proper repair. In the Coal Creek Drainage and Levee District the levee was build sufficiently high and strong to stand the floods. A large part of this drainage district is flat land of heavy soil and requires tile drainage before it can be successfully farmed during such wet years as 1902 to 1904 have been.

There are now projected and either under construction or survey six or eight drainage and levee districts in the Illinois River valley, ranging from 2,000 to 14,000 acres each and having an aggregate area of probably 50,000 acres. These are located at intervals from Chillicothe to the mouth of the river. The expense of building substantial levees, interior drainage ditches and pumping plant of adequate capacity to provide effective drainage is more than the landowners generally have been willing to invest in such improvement. The cost in the three drainage and levee districts above referred to as having been constructed, range from $12 to $18 per acre. In two of them the levees and interior drains were both insufficient. In one the levee has been sufficient but the interior drainage has not been sufficient. In all three, a railway embankment across the valley at the upper end of the drainage district has been used as a part of the levee system and to that extent has reduced the cost. From estimates made by one of the members of this Committee, it would appear as if adequate levees, ditches and pumping plants for a tract of land of 4,000 to 8,000 acres under average conditions in the Illinois River valley will cost in the neighborhood of $20 to $25 per acre.

There has been much difficulty experienced on the part of the commissioners of the drainage and levee districts now proposed, in finding purchasers for the bonds. Illinois drainage bonds generally have been based on $3 to $5 per acre, and when it is proposed to sell bonds which represent $15 to $25 per acre, the brokers, so far as the writer knows, declined to consider.

Under the direction of Mr. Elliott, Drainage Expert, Department of Agriculture, Washington, D. C., and Chairman of this Committee, extensive investigations were made during the year 1904 with reference to the drainage and levee work in the Illinois River bottoms, and the following data and conclusions are taken from a report prepared by Mr. Elliott from such data in response to inquiries from interested parties:

> The Lacey levee and drainage district covers 5,180 acres and is protected by 9.5 miles of levee, 7 miles being new work and the other 2.5 miles being an old railway grade which was built a number of years ago. The average height of the new levee is 8 ft., slopes 2 to 1 on the river side and 1 to 1 on the land side, made by scrapers, all the earth being taken from the river side, leaving a berm 10 ft. between the borrow pit and the top of the levee. The foundation was made by thoroughly clearing stumps, and a center ditch 4 ft. deep was scraped out and filled with good material. This

work was let at 7 to 13 cts. per cu. yd. according to height, but the contractors proved irresponsible and the work was finished at 25 cts. per yd., making the estimated average cost 12 cts. for the entire work. The levee was finished with an 8-ft. top.

The Pekin and La Marsh district covers 2,500 acres. The levee was constructed without any special preparation of the bottom, river slope 1.5 to 1, land slope 1 to 1, with 3 ft. top. This work was done by scrapers at a cost of 12.5 cts. per cu. yd., though for some bad sections 25 cts. per yd. was paid. The first 2 ft. in depth of the surface are composed of sand and silt through which the water seeps quite badly. The immediate cause of failure of both the levees just described was their lack of height. With reference to the lessons which those immediately concerned in their construction have drawn from the failures, I will quote the conclusions first of Mr. Lyman Lacey:

"Levees should be built with 3 to 1 slopes on both sides and with a top width of 8 ft. After the work is done the slopes should be harrowed and fertilized, then sown with 2 bushels of blue grass and 4 bushels of red top per acre and afterward rolled. When the grass has grown, pasture the levees when not soft, as the tramping keeps the surface firm. Weeds should not be allowed to grow for they die and loosen the earth when they decay. Willows should be planted a short distance from the foot of the levee for a wave-break. A ditch 2 ft. deep should be dug 10 ft. inside the foot of the levee to carry seepage water to the drain ditches."

Second, those of Mr. H. W. Mattheessen, commissioner of the Pekin and La Marsh district, who says:

"Foundations for embankments should be grubbed and cleared of all vegetable matter, plowed, and a small ditch made in the center; the levee constructed with 2.5 to 1 and 1.5 to 1 slopes with an 8 ft. top which should be used as a road and sown to grass. Willows should be planted along the outside 50 ft. from the levee. No weeds or bushes should be allowed to grow on the banks as they loosen the surface and protect burrowing animals. Pasturing keeps the surface solid, diminishes the risk from the work of the crayfish, and keeps the surface clean so that animals working in the bank can be seen. Using the top as a roadway prevents moles from working in it and dogs accompanying farmers who pass back and forth scare small animals away."

The Coal Creek levee district near Beardstown is interesting from the fact that the levee was constructed with a 2.5 yd. dipper dredge. The district contains 7,000 acres. The height of the levee is 3 ft. above the high-water plane of 1844, 22.4 ft. above present low-water mark. The specifications required it to have a slope of 3 to 1 on the outside and 2 to 1 on the inside, with a berm of 20 ft.; no special width on top. All the earth was excavated from the outside. The main difficulty experienced in construction was that the earth when dropped by the dipper spread out and the entire height could not be made at one passage. It was necessary for the dredge to pass over the work three times in order to construct the levee. The work was taken at 9 cts. per cu. yd. for 600,000 yds., but it is estimated that fully 1,000,000 yds. of earth were placed in the levee. The foundation of the levee and the borrow pit were cleared, stumps dynamited and pulled, and all roots taken out to a depth of 3 ft. The timber was cut and piled upon the berm. The levee as built by the dredge is rough and irregular both on top and on the slopes, caused by dumping 2.5 yds. of earth at a time. In finishing, many places were a little low and it required only a small amount of material to fill them, while the whole dipperful was dropped. The result was a tendency of the banks to run and slide while under construction. The soft condition of the material when dug out of the water makes the embankment ultimately more compact and solid than when dry earth is deposited by scrapers. This dredge levee at the end of the first year showed a shrinkage of only 2%, and at the end of the second year, none. Scraper work usually shows 10% shrinkage, while 3% is thought sufficient to add for dredge levees.

Mr. F. J. Traut, who had charge of construction of this work and who has watched it closely, has this to say regarding the proper method of construction:

"The right-of-way should be cleared and the roots taken out to a depth of 3 ft., and the timber piled on the berm. The timber will become covered with dirt during construction and will in that way strengthen the foot of the levee. A muck ditch should be dug under the levee deep enough to cut through the vegetable matter and then filled with clay. A dredge for levee work must have a boom that will reach a little beyond the center of the levee. A slope less than 2 to 1 cannot be built with a dredge. It should be a 3 to 1 on the outside and 2 to 1 on the inside. In crossing sloughs where the material is unusually soft, let it spread wider than the required section. The dirt should be dumped in the center and let run to the sides until it reaches the proper width; then the boat must move on. When the bank has dried sufficiently to stand another layer, it can be put on. Therefore the boat will have to pass over the work two or three times. The weakest place in the levee should meet the requirements of a theoretical cross-section. When finishing, a man stands on the bank to indicate where the material is needed. A short pole is set where the dipper is to be dumped and is jerked away by a line as soon as the dipper swings over the spot indicated. A road on top of the levee is of no benefit as it should not be traveled in wet weather on account of cutting ruts. The slopes should not be dressed up, as the rough uneven surfaces help to break the waves and prevent the levee from being washed by heavy rains. Nothing will grow on the banks the first year and it is difficult to get grass started by reason of the irregular and loose condition of the rough bank."

The following deductions applicable to the construction of levees along the Illinois river are made from information we now have: 1, The old levees as constructed were carelessly made both with reference to the preparation of the foundation and the section. 2, They have failed because in some instances they were not high enough and in others because they were too weak.

The conclusions which Mr. Stewart draws from a general study of the situation are:

1. The preparation of the base of the levee should be made by thoroughly clearing off all vegetable matter and in all cases a muck ditch to the depth of the soil, which is not less than 2 ft., should be dug and filled with good material to prevent seepage.
2. The side slopes should be 3 to 1, though it is possible that 2.5 to 1 on the land side will be sufficient. Many of the levees studied have been injured more by breakage occuring from the interior waves than from the action of water from the outside. Going upon the theory that the levees will never break, the inner or land slope need be only 2.5 to 1.
3. The slopes should be well sodded with grass and if possible pastured by live stock, otherwise they should be mowed and kept clean in order to keep the surface compact, and, further, a row of willows planted at any convenient distance from the base of the river side of the levee will greatly aid in protecting it from wave action during flood time.

It has been observed that there is more danger from erosion by waves from still water than by those from a running current, and further, that a running current is not sufficiently affected by the wind to cause serious wave erosion. This point should be considered in the location of levees, since if they are located some distance from a running current, practically forming a lake between the main stream and the levee, when the water is at flood height more difficulty may be expected in preserving the face of the embankment. In view of these waves, which are liable to be important factors at any time, the levees should be 3 ft. higher than the actual water plane of flood height. Again, as to section, the value of the broad base and flat slope appears when the levee is called upon to resist the water for a long time. A levee which will successfully resist a flood for a week will fail if subjected to the same conditions for four weeks because the water softens the material and makes the entire levee less stable. In establishing these points, it is well to consider the possible loss that would accrue to property by reason of one failure and compare it with the additional expense of making the levee as stable as good practice in engineering would dictate. The material usually found along the river is good for levee construction provided the surface soil be properly prepared and the seepage through it cut off in the way above indicated.

I take the liberty of referring you to what has been adopted as the standard section for the levees of the Mississippi, described in a paper in volume 39 of the Transactions of the American Society of Civil Engineers, together with discussions upon the same by various members of the Society. The section given for levees 8 ft. high is 3 to 1 slope on the river side and 2.5 to 1 on the land side, with a top width of 8 ft. For levees 11 ft high, both slopes are 3 to 1 with a reinforcement called a "banquette" on the land side. A top width of 8 ft. is standard for all heights of levees. It has generally been conceded that they should be built 3 ft. higher than the high-water plane.

Another subject is the matter of the construction and maintenance of open dredge ditches where the soil or subsoil or both are water bearing sand or quicksand. There are many situations where drainage is required where there will be found a top soil of 1 to 6 ft. deep underlaid with water-bearing sand. In order to have an effective drainage it has been found that open ditches should not be less than about 6 ft. deep to provide for adequate outlets for tile drains above the ordinary stage of the water in open ditches. In some localities much difficulty has been experienced in digging such ditches to grade and maintaining them at grade. This subject was also investigated by the United States Department of Agriculture under the direction of Mr. Elliott, and the following observations of ditches constructed in the southeastern part of Missouri are taken from the report prepared from such data:

In the construction of drainage ditches in this section of the country it has been the custom of contractors to make the ditches 1 to 2 ft. wider on the bottom and about 1 ft. deeper than specified. The contractors would rather provide for the disposal of caving material in this way than to go over the work again and clean out the material that may have fallen in. In some cases it is necessary to do this, but in the majority of cases very little material falls into the ditches during construction, so that most of them when accepted by the engineer are larger and deeper than specified. As most of the trouble arising from caving occurs during the spring immediately following the heavy frosts, it is seasonable with the high water. Where the ditches are given sufficient grade, the material that sloughs away, or most of it, is carried away in suspension, so that in most cases a ditch made 1 ft. deeper than called for in the specifications generally requires one to three years to bring it to grade.

From statements of various contractors and landowners it is learned that a ditch with a fall of 18 ins. or more to the mile will keep its channel comparatively free from filling up. Where it has been possible to get such a fall and a free outlet, the future maintenance of the work is regarded as a very minor proposition. In such a case the cross section of a ditch will change materially, but its carrying capacity and efficiency will undergo little or no change. So far, it has been impossible to obtain cross sections of the original ditches, and the comparisons made are between ditches of the same size and depth and through the same kind of material. The main ditches are nearly all the same size. All the dredge ditches are very similar in cross sections immediately after construction, so the comparison in Fig. 1, although the figure is a composite of two ditches, is a fair representation of the change in shape two years after construction of a ditch having a fall of 18 ins. per mile. Mr. Ehmerine, the dredge foreman who constructed

Fig 1
Showing Change in Shape of
Ditch in 2 Years Time Stoddard Co Mo.
Ditch has a Fall of 15 Ft per Mile

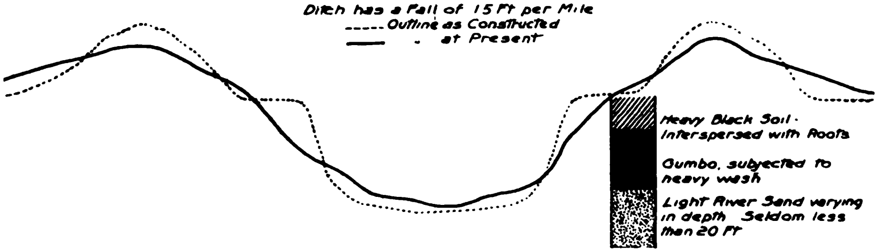

----- Outline as Constructed
——— " at Present
Heavy Black Soil Interspersed with Roots
Gumbo, subjected to heavy wash
Light River Sand varying in depth Seldom less than 20 Ft

Fig 2
Showing Change in Shape of Ditch
in 1 years Time
Ditch has a Fall of 12 Ft per Mile

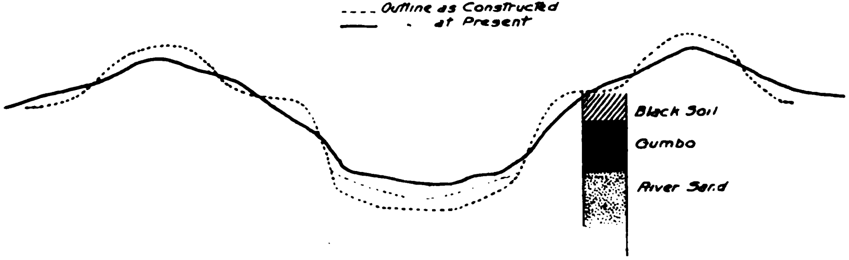
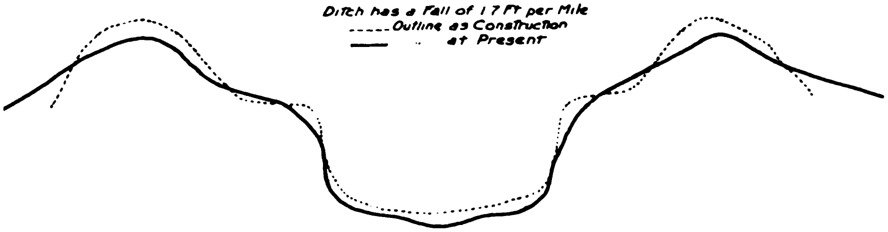


Fig 3
Showing Changes in Shape of Ditch
in 3 Years Time
Ditch has a Fall of 1 7 Ft per Mile



this ditch, says that when accepted by the engineer it was 0.6 to 1 ft. below grade. At the end of two years this ditch is found approximately at grade.

Fig. 2 is a cross section of a ditch on a grade of 1.2 ft. per mile. It was excavated about 3 ft. into the sand, being made a little deeper into that stratum than the ditch shown in Fig. 1. This ditch was excavated about 0.8 ft. lower than grade, but before accepted by the engineer it was practically at grade, due to the running in of the fine sand. At that time the ditch was supposed to have taken permanent shape, but its present appearance suggests that by reason of water action the sand was brought into the ditch in the way shown by Fig. 2, before the side slopes had caved in. When this material fell in, there was not sufficient current to carry it away, and the bottom sand being covered, further scouring was checked. Though this ditch had been constructed only a little over a year, preparations are now being made to clean it out and deepen it. Such an improvement has been made impossible by reason of additional drainage work which has been done below the outlet, thus securing a lower point of discharge.

Fig. 3 shows a ditch constructed through practically the same material as that shown in Fig. 2, but with a greater grade. In this case the grade has produced a velocity of flow sufficient to not only carry away the material that has fallen into the ditch but to enlarge that part of the ditch which is in sand. The ditch is owned by the Johnson Land Co., Scott County, Mo. The only trouble experienced in its maintenance has been in keeping it clear from bars or drifts. Since the occupation of the land on both sides of the ditch, little or no trouble has been experienced. The company's instructions to renters fully cover the maintenance of the ditch and require that such obstructions as would form sand bars or drifts be promptly removed. A ditch of this kind is, however, an exception, since this level country does not as a rule admit of such heavy grades.

It is argued that as long as it is necessary to go over the ditches at least once after construction, it is cheaper to dispose of caved material at that time than to raise the contract price of the work by inserting clauses in the specifications requiring the contractor to make the section of the ditch large enough to allow for such caving as may take place. It is the general opinion that ditches to remain efficient must be cleaned out about every third year. This has lead to a laxity in the framing of specifications and the general construction of ditches. Dredge men have a decided preference for work in this section as the sand encountered causes very little trouble or expense in moving. In several instances it has been necessary, in cutting through ridges, for the contractor to go over that particular piece of work two or three times, but this is no great hardship as the distances where it is necessary to do this are invariably short, and as before stated, where the ditch has sufficient fall the maintenance in such places is a minor consideration.

The construction and present appearance of these ditches suggest:

1. That the cross section of ditches in this locality is not materially changed on account of the sand encountered.
2. That in ditches having a fall of more than 1.5 ft. per mile, it will not be necessary to clean out the material that has fallen in, oftener than once in three years.
3. That where ditches do not have this great a fall, it is necessary to clean out the caved material the first year following construction.
4. That with a wider berm and a more strict adherence to proper slopes and the disposal of excavated material, the caving of material, which seriously affects the flow of water, would in a great measure be averted.

The Committee requested Mr. J. L. Clark, one of the older members of the Society, to write a paper from his own observations, opinion and experience upon this matter of the construction and maintenance of ditches in sand. He declined to write a paper but sent a letter giving a very interesting account of one of his experiences upon this subject. He had read the notes from the investigations made under Mr. Elliott's direction regarding the ditches in southeastern Missouri and in his letter made the following statement regarding the same:

> My experience with dredge ditches where they have been in the main either clay loam or gravel and only strike sand at or near the grade line, is much the same as reported, but when it is a sandy loam or sand on top and quicksand or even water-sand below, I find it very different indeed. It is very difficult to get a ditch down to grade and keep it there long enough to inspect it while the ditch is full of water, and dredge ditches usually are full during construction, unless the digging is up stream. The banks cave in less than one would suppose, yet the sand will continue to run in at the bottom. I have found at the stern of a boat 85 ft. long, the bottom of the ditch 2 or 3 ft. above grade, and after the water had receded the sand did not scour out even though the fall in the case referred to was 0.9 ft. in 100 ft. In this case the cut for the distance of 1,200 ft. was from 12 ft. 3 ins. to 15 ft. 3 ins. in depth.

The ditch above referred to was constructed in 1897 and levels were taken through this cut in the fall of 1904, which indicated that the grade line of the ditch was slightly higher than when the water first went down after the dredge.

Mr. Clark's letter also gave the result of a report upon a ditch which he had heard but regarding which he was not personally familiar. In the construction of the ditch the sand came in, in about the same manner as above described and after the water had run out the weight of the spoil banks had seemed to press the upper soil down and in a great measure stopped the flow of the quicksand in the ditch so that four years after the first work was done the ditch was cleaned out and no trouble was experienced in digging to grade. Mr. Clark closes his letter by summing up as follows: "My experience is that in clayey soils ditches will scour with a fall of 2 to 2½ ft. to the mile. In sandy soils they will not scour with 5 to 5½ ft. to the mile."

The very extensive amount of cleaning and deepening of open ditches which has been done during the last two years and is now in progress throughout the State of Illinois leads the Committee to believe that this question of the grade, the depth and the proper cross section of ditches is very important, not only as to the carrying capacity and first cost, but also in the matter of maintenance.

C. G. ELLIOTT, J. A. HARMAN, A. L. WATERBURY.

(This report was prepared mainly by Mr. Harman.)

DISCUSSION ON DRAINAGE.

MR. A. H. BELL: About 18 years ago I engineered a drainage district in Mason and Tazewell counties embracing some 35,000 acres. There was one main ditch cut that was 40 ft. on the bottom and 60 ft. on top (those were about the average dimensions), which had a fall of about 1½ ft. to the mile. Then there were four lateral ditches ranging from 30 to 40 ft. on top. That main ditch has kept itself in good condition until within the last few years. Then they allowed willow trees to grow, and within the last year they have contracted with a dredge boat firm to clean it out. The lateral ditches have maintained themselves without any trouble. That was the first work that I know of done in this State by dredge boats in the way of land drainage. The land was not worth more than $10 or $15 an acre, but within 1½ years after those ditches were dug, that land was worth $50 or $60, and it is now worth from $125 to $150. Mr. Harman spoke of the Green River district, that is in Henry and Bureau counties. They propose to cut a ditch 23 miles long, 80 ft. wide on top and increasing to 110 ft. There are 10 or 12 smaller laterals coming into this ditch, making about 4,500,000 cu. yds., at an estimated cost of about $420,000. This work is proposed to protect about 34,000 acres from overflow.

The soil in Mason County is a black prairie soil about 4 ft. deep, and under that was a white water-bearing sand. A great deal of it, in fact, was quicksand. There was not much difficulty in holding the ditch to grade. The contractor did have to dig somewhat deeper, probably 1½ ft. below grade wherever he struck what was practically quicksand. It ran in, but after he got down into it, the weight of the banks seemed to press down and cut it off. As to dredged ditches in Illinois, I know of very few cases where they have had to be cleaned out.

MR. W. P. CHASE: Clinton County, Iowa, is about half a marshy district. It lies between the Mississippi River on the east and the Wapsipinnicon River on the south and the Maquoketa River on the north, almost entirely surrounded by rivers, just at the point where they empty into the Mississippi, and it has considerable low land. We have inaugurated three drainage districts, comprising about 40 miles of ditch, not mentioning any tiling that may be done; two of these have been surveyed and reported on, and the third is now under survey. Some engineers in Iowa have had trouble in getting their pay. This new law says that the property owners shall put up a bond of $500 to cover the preliminary expenses, and that the Board of Supervisors shall engage an engineer to do the work. Some boards have claimed that as the people had to put up the bond, they have got to pay the bill, and all they had to do was to hire the engineer and make a contract with him and go to all the expense, and then he could look to the people for their pay. As a result of that, there are some engineers in Iowa who are at present looking for their pay, and as I read that law, they will look a long while unless they hold the Board of Supervisors. I don't believe in an engineer being required to give a bond to perform his duty. I have built a few drainage ditches in eastern Iowa. They are all through clay soil or black soil, and have a fall of about 3 ft. to the mile. One of these ditches, which drains a territory of several square miles, has operated successfully for the past five years. It has only been cleaned once, and it has kept in good shape.

MR. J. F. SCHMELTZER: We have a great many small drainage districts ranging from 20 acres up to 200 acres. They organize a watershed into a drainage district, put in a main line and run a lateral to every man's line to give him drainage. At present I am constructing a 24-in. main tile through a sandhill. The cut is over 8 ft. most of the way. The grade is 0.11 per 100 ft. We have some small patches of quicksand, but have managed to fight through.

MR. MELLUISH: For the run-off per square mile allowed in computing the Iowa drainage ditches, I figured the run-off from the U. S. Government precipitation records of the nearest weather bureau station, with reference to the topography and nature of the ground in each watershed. It might be different for the different parts of one county. Take Pocahontas County, for instance; the run-off is twice as great in the northwestern part as it is in the central part. I use a modification of the Buerkli-Ziegler formulas, using co-efficients which my experience and research work in drainage have proved efficient. The results have been uniformly satisfactory. As to making underdrains through quicksand, it would be my opinion that silt-basins should be provided for effective, continuous drainage. In trenching through quicksand I have used muslin, building paper, straw, wild grass, or cobs, according to the severity of the case; and in some work have substituted hub-and-spigot sewer pipe with caulked joints for drain tile, in order to keep out fine sand and silt.

In regard to the maintenance of ditches, I have a drainage district in Livingston County, Illinois, at present in process of having its main channel repaired. The channel is six miles long; the lowest two miles has a fall of 3 ft. per mile and is through average prairie land; the central two miles has little or no natural fall; it is an envelope of peat marsh, the peat being 4 ft. deep and underlaid with 6 ft. of fine, white sand. The uppermost two miles has a fall of 12 ft. per mile, and the channel is cut through a clay gravel. This drainage district was organized in 1896 and the work completed in that year; by 1901 (five years) the central two miles was entirely filled up and it is sought to be repaired now. The difficulty here lies with the high gradient at the upper end, which scours and fills the central portion of the ditch. The remedy which I adopted was to carry the drainage water from the uppermost two miles through a 27-in. salt-glazed tile, which intercepts the several lines of tile draining its watershed. In this way we will eliminate the scour from the upper sections's filling the central section. We will drain off all but excessive rains through the tile. Unusual rains or flood will be temporarily relieved by the old open ditch.

MR. MCCLANAHAN: In regard to the bond required from the engineer, I have wondered what the bond was for; whether it would be made the basis for damages if he failed to get the water flow line in his ditch according to his profiles, or whether he would fail to have a sufficient number of mains and laterals placed in a position that would make a complete job of drainage for the district. At one place in Iowa we found hard pan; we cut a ditch 4½ ft. deep into it, and filled over the tile with upper soil, and the drainage was successful. They had been draining in that same neighborhood with a tile depth of only 2½ ft., which was not a success. I suppose all of you are aware that tiling is as good in dry weather as it is in wet weather. If the tile has been put below the dew point, whenever the tile is empty the air passes right into the tile and becomes moist and is carried up through the soil.

MR. HARMAN: One report has called attention to the belief that it was necessary in southeastern Missouri to clean out the ditches about every third year. So far as Illinois experience goes, that has not been so, and if some ditches needed cleaning at the end of the third year, it was because they were not made large enough. In eastern Illinois, where there is a heavy clay soil and a great deal of drainage was carried on for 10 years, beginning 20 years ago, a great many open ditches were made. Most of them were apparently large enough, but the farmers neglected them, and there was growth of weeds and willows, and in the last few years of extremely heavy rainfalls many of these ditches have been cleaned, and in most cases with dipper dredges.

An English writer states that in one main drainage ditch, 12 miles long, successfully draining a large tract of land, there was 9 ins. of fall. The ditch required some attention each year; the weeds had to be cut and taken out of it, and occasionally they ran a drag through it to stir up the bottom at flood time, and any little silt or sediment that had been deposited would be carried to the outlet. The Illinois farmers have not begun to appreciate the real need of maintaining their ditches, but think they ought to run on forever.

MR. J. L. CLARK: In 1881 General Cass wanted me to dredge his marsh land, and we built a couple of these old apron dredges. We put them up right there on the Monon R. R. at Shelby, started a ditch there and dug about 60 miles of drainage ditches. Today those ditches are doing good work. They were dug in 1881, 1882 and 1883. Now a dredged ditch needs a little watching. I have had bad luck with sand. In reference to laying tile, I tried an experiment this year on quicksand. I was required to go through a hill and drain a 30-acre pond. It was an 8-ft. cut, 800 ft. long, and we found about 18 ins. of quicksand in the bottom. The ground was very dry and by only making 25 or 50 ft. of ditch at a time, the banks would stand. We dug the trench 8 ins. wider than necessary to receive the tile. In the bottom we put the best tarred paper we could get and had it wide enough to wrap the lower half of the tile, and pressing it against the tile filled all around it with black loam and also put about 2 ft. of loam above it, hoping in this way to make a filter which would prevent the sand getting into the tile, which in my experience, seems to be the whole cause of the displacement of the tile.

MR. SCHMELTZER: In three districts last summer we used what is classed as vitrified drain tile, made of the same material as sewer tile without flanges. They are much superior to any sewer tile, especially in the large sizes, 24 in. In one district they used soft, common drain tile. The cut was only 8 ft., and we had considerable trouble by smashing of tile, through caving in on top of the tile. The contractor now has a bill for something like $4,000 extra, a large part of it for digging out tiles that were smashed after he put them in. In one of the districts there is 4,300 ft. of 24-in. main tile, and 2,800 ft. of 22-in. main tile. The aggregate of the large tile comes up to something like 3,400 ft. in the whole district. The tile in that district is furnished by the National Drain Tile Co. It is not an ordinary red drain tile, but it is considerably harder and apparently much stronger. It is made out of shale and not out of clay. We put in three districts with the Buckeye traction ditchers; where we had ground that was reasonably firm to carry them, they did their work very cheaply and did it well. In one soft place the tile had to be put in by hand. The larger machine will cut a ditch wide enough for 24 in. tile and 7½ ft. deep; the smaller one will make a ditch for 12 in. tile, 4½ ft. deep.

MR. A. W. GATES: The Monmouth Mining & Mfg. Co. finds that its business in the larger sizes of vitrified tile has been increased very materially in the last two or three years. There seems to have been a great deal of trouble on account of the larger sizes of red tile breaking and caving in, and during the past year we have sold vitrified tile to replace red tile in several places. We think the hard vitrified tile is very much superior to the other, although the cost is somewhat greater, and there seems to be a tendency to use it in place of the red tile for the larger sizes.

MR. MEAD: I would like to thank Mr. Shaw for his very generous and manly statement of Mr. Rutlidge's connection with the Inlet Swamp drainage problem. I happen to know considerable about that matter. Mr. Rutlidge, previous to his taking hold of that work, was in my office, and all his office work was done there at that time, and I know how much he was annoyed at the time with the reduction of the size of his ditches by the court and the drainage commissioners. The reduction, I think, was due partially to two reasons: One was the idea of both the court and the drainage commissioners that, perhaps, the sizes were rather theoretical and above the actual needs; the other was the limit of the tax which could be put upon the farmers of this drainage district. The sizes were very materially reduced, as Mr. Shaw has stated, and I think this illustrates a matter of great interest to us all individually; that is, the fact that work which is sometimes done under difficulties and under protest by an engineer, may be later on charged up against his engineering knowledge and ability.

STREET PAVING IN QUINCY.

BY F. L. HANCOCK (MEMBER).

Brick pavements were first constructed in Quincy about 15 years ago. There are now 22.53 miles of such pavement and 11.20 miles of macadam and telford roadways, a total mileage of 34.01, with a total mileage of unimproved streets of 56.87.

The first brick pavement had a double course of brick on a broken stone foundation with a sand cushion of 3 to 4 ins. This double course work was soon abandoned and a single course adopted with a 6-in. broken stone foundation and a 3-in. sand cushion. With the exception of a small per cent. of the total mileage thus far completed the pavements are all single course, and considering the amount of heavy hauling that is done in the business and manufacturing districts the work has stood well. This is attributable primarily to the almost perfect subgrade thus far found; being situated on the bluffs and having opportunity for perfect drainage. Where our work on a broken stone base has been successful it would have failed in many places where the subgrade offered less resistance, and I do not advocate a broken stone base in all localities. A concrete base is the cheapest in all cases, and the resistance of a rigid base will add at least 25% to the life of any pavement.

No grouting has been done. We cover the finished work with sand and the interstices are filled in this way. This is a cheap method as compared with grouting, but from many points is very desirable. The rumbling noise of a pavement is increased, if not produced by sand and cement grouting. There is little or no flexibility in these fillers and the pavement if thoroughly supported by a firmly anchored curb cannot move uniformly but in places it will rise from the base and the space thus created between the foundation and the pavement is the cause of the rumbling sound. This is noticeable in summer when the temperature is high and expansion takes place. A first class asphalt filler is the best that has been used on brick pavements; it is sanitary, non-absorbent, and flexible, qualities that are essential. I have seen a sand filled pavement in an alley adjacent to a livery stable that was flushed with water every day in hot weather. The refuse from the stable mingled with the water that percolated into the sand filler, making it very obnoxious and also a menace to health.

The failure of any brick pavement with a broken stone base is certain if the subgrade and stone base are not thoroughly rolled, and the sand cushion thoroughly watered. The sand if thoroughly flushed into the voids forms a monolithic mass almost as solid as concrete, as long as it is not disturbed. If, however, the flushing is done to suit the contractor and save sand, then as soon as the pavement is opened for traffic, the vibration of the pavement will sift the sand into the voids where it should have been flushed, and the result is a shifting of the brick as the cushion disappears. While this shifting movement is very slight at first it is constant until the voids in the base are filled, and usually a very rough and uneven pavement appears in a short time, which condition aids the rapid destruction of the brick. The life of any pavement built of good or poor brick is dependent very largely upon the rigidity of the base.

The cost of repairing brick pavement is an important matter, but the difference in location of the work and in conditions under which the work is done, is such that it is very hard to get an average cost per yard of this work. I have kept some accurate records from a piece of work 400 ft. in length by 20 ft. in width. This can hardly be called a patch, as it extended for a block in length and is the center 20 ft. of a 50-ft. roadway. It shows that it is better to get the limit of wear out of a pavement, and then relay that portion destroyed in its entirety. Patching should be eliminated wherever possible. The result obtained in all patch work is disappointing no matter how well it is done. On this work a strip 26 ft. wide was opened the entire length, and the old brick cleaned away and the proper crown shaped up; a row of bricks was laid parallel to the curb line and the brick laid at right angles to this line of brick to the line set on the opposite side, the strip being 20 ft. wide. Then the space of 3 ft. on each side of the new work that had been taken out was filled in with the best of the old brick to join the new work. Only about one-fourth of them could be used to tie in the new work. The cost per square yard for the finished work, with brick at $13.60 per 1,000 delivered on the line of improvement, sand at $1 per yd., and labor at $1.50 per day, was 97 cts. per yard.

My attention has been called to some rock asphalt laid in Philadelphia on Broad St., a prominent thoroughfare. This asphalt was laid on old belgian blocks which had become very rough. The pavement was washed off very carefully and the asphalt applied to the blocks. No binder course or other work is required to resurface an old pavement with this material. This material, after 6 years of constant wear, is in fine condition, and if it can be placed over old brick pavements at the price given by Mr. Shields, of that city, it is a very desirable improvement.

In Quincy, as in other cities, the water works, steam heat, gas and street railway companies, and the ever-busy plumber with lateral connections to sewers, have all worked industriously to destroy the pavement. The street railway company is about the worst, as the number of breaks in water and gas pipes that are traceable to electrolysis are larger each year. Where openings are permitted to be made, the city requires a bond and permits are issued in the regular way, the plumbers and others permitted to make openings are constantly relaying and repairing their work, and at the same time there is a large portion of the streets that it requires no little effort to keep in reasonable condition.

About three years ago I drafted an ordinance, which the city council adopted, governing the manner in which openings might be made in paved streets and as far as it has been possible to enforce it the result has been very satisfactory. I believe that I have brought out some new ideas as to the method of back-filling and Section 7 of the ordinance is appended.

The pavement along the line of the street railway tracks formerly caused much trouble, much of which has been eliminated since new 70-lb. T rails have been placed. Our street railway was formerly a mule car line with light tram-head girder rails. The new electric cars were placed on the old track, but their weight caused a rolling motion of the track and raised the pavement ties, track and all to a higher elevation than the pavement adjacent to it, and stood many of the brick on end. This was caused by the sand shifting under the ties by the vibration of the cars. The rail as now laid is giving good satisfaction and is placed in such a way that no movement is taking place, the old macadam is taken out and the tie bedded in foundry cinder, watered and tamped; then a strip of lumber is placed next to the rail and the pavement laid up to it, forming a fair groove for the flange of the wheel. It has been the plan to make this groove narrow enough that wagons will not track in it.

In closing I wish to suggest that the Committee on Paving next year be requested to secure all the statistics obtainable relative to the costs and merits of rock asphalt for covering old brick pavements.

Ordinance Regulating the Manner of Making Openings in Paved Streets and the Back Filling of Same:

Sec. 7. All openings made in paved streets in this city for any purpose, including the laying or repairing of gas, water or steam heat mains or pipes or connections and the building or repairing of sewers, sewer connections, tunnels or drains, shall be made for the full length and width in or for which it is intended to do work in said streets. No tunneling shall be done under any paved street or sidewalk. The openings shall be made to such a depth as is required for the work intended to be done and shall be of such a width as will permit the work to be readily done in a workmanlike manner in the open trench or excavation without tunneling or digging under any portion of the paved street. Where the opening does not exceed in depth 4 ft. the opening in the paved street shall be back-filled in the manner herein provided. The opening shall be filled with sand up to the original subgrade of the pavement. The sand shall be sufficiently wetted to thoroughly pack the same and shall be tamped and made at every point to conform to said original subgrade of the pavement. Upon this subgrade the pavement removed shall be replaced exactly in the same manner and same courses in which it was originally constructed. The pavement when replaced shall be at all points even and flush with the pavement of the adjoining portions of the street. If any of the material which formed the original paving shall have become mixed with the earth taken out in the excavation, or shall become unfit for use, it shall be replaced by new material. If at any time within the period of three years from the time said excavation is made said pavement shall not be flush or even with the adjoining portions of the old work, that is to say, the adjoining portions of the pavement as originally laid, the same shall be taken up by the company, companies, corporations, person or persons which made the opening and shall be replaced in such a manner as to make the same flush and even with said adjoining old work. If the excavation in the paved street exceeds 4 ft. in depth, then instead of back-filling the same up to the subgrade of the original pavement with sand as hereinbefore provided, such opening may be back-filled in the following manner:

The earth may be deposited and replaced in the excavation in layers of one foot in depth up to said original subgrade of the street pavement, each layer of 1 ft. in depth shall be thoroughly tamped before a new layer is placed in said opening. After the original subgrade has been reached a bench of 1 ft. in width shall be cleared away on each side of said opening, that is to say, the pavement shall be removed a distance of 1 ft. on each side of said opening, for the purpose of building a concrete arch over said opening. On the subgrade for said pavement over said opening and for the distance of 1 ft. on either side thereof shall be placed a bottom layer of concrete 6 ins. in thickness, brought to an arch at the center of the opening. Said concrete shall be composed of 1 part (by bulk) of fresh ground hydraulic cement, 2 parts of clean, sharp, well-screened river sand, and 3 parts of broken stone; the sand and cement shall then be thoroughly mixed dry and made into mortar of proper consistence with the least possible amount of water and thoroughly worked; the broken stones shall be thoroughly cleaned and free from dirt; well drenched with water, but containing no loose water in the heap and shall then be added to the mixture. The same shall then be thoroughly mixed and spread upon the said subgrade over said opening and bench on each side thereof, prepared as above designated and thoroughly compacted by ramming until free mortar appears upon the surface. The upper surface of said concrete, when thus prepared and placed, shall be parallel with the surface of the pavement when completed. Upon this concrete foundation, prepared as above designated, there shall be spread a layer of clean, sharp, well-screened river sand three inches in thickness. Upon this cushion of sand shall be placed the upper courses of the pavement in such a manner as to make the top of the same at each point flush and even with the adjoining portions of the pavement.

REPORT OF THE COMMITTEE ON ROADS AND PAVEMENTS.

JOINT FILLERS FOR BRICK PAVEMENTS: For the smaller towns or cities, brick pavements are preferred for several reasons: 1, They are easy to construct and maintain. 2, Their first cost is comparatively low. 3, They can be more easily repaired than asphalt in case the street is opened for gas, water or sewer pipes. 4, They are durable. For these reasons this kind of pavement will continue to be used for some time to come, and some expedients for their betterment will be considered. The extremely low price at which Portland cement can be obtained makes it more economical to use a lean Portland cement concrete than a rich natural cement. The former being about 10% cheaper and 50% stronger than the latter.

The proper treatment for the joints of brick pavements is quite important, and yet it is a feature that does not receive the same amount of attention as the selection of the brick or the construction of the foundation. This neglect is probably due to the fact that it has been difficult to obtain a filler which will meet all of the requirements. The interstices between the brick should be filled with a material: (1), to keep the brick in proper position; (2), to lessen the chipping of the corners and edges of the brick; (3), to prevent the water from entering the joints and penetrating to the foundation, and (4), to render the pavement as free from noises as possible.

Sand was the first filler employed for brick pavements, and is now more extensively used for that purpose than any other material. The advantages of a sand filler are: 1, It is cheap, usually costing not more than 2 cts. per sq. yd. 2, The pavement may be put into use as soon as the brick are laid, and the cement in the foundation set so as not to be damaged by the rolling and the traffic. 3, The pavement may be taken up easily to make any underground repairs without damaging the brick. 4, The pavement will be ironed out under the traffic, and will become smoother after it has been in use for awhile than it was when first thrown open. The disadvantages are: 1, The sand does not protect the corners and edges of the brick and keep them from chipping. 2, It may be washed out on steep grades by the rains and by the flushing of fire hydrants. 3, It may be removed from the top of the joints by the street sweeper or the pneumatic cleaner. In the last two instances, the crevices become filled with droppings and other decaying matter, which is an objectionable feature. 4, The filler does not remain flush with the surface of the brick, causing the passing vehicles to jolt and rattle with considerable roar and noise.

Next to the sand, in point of extent in use, is the Portland cement grout filler. It is prepared by making a thin mortar of neat cement, or 1 part of cement and 1 part fine sand, the latter proportions being the more common. This mortar is swept into the interstices. Where this filler is used, expansion joints should be provided both transversely and longitudinally. The cost of 1 to 1 Portland cement filler will be from 8 to 12 cts. per sq. yd., the higher price being paid where extraordinary care in mixing and applying was employed. The advantages of a cement filler when it is properly applied are: 1, It thoroughly protects the corners and edges of the brick. 2, It cannot be washed or swept out of the joints. 3, Water cannot penetrate the pavement and reach the foundation. 4, It makes the pavement thoroughly sanitary. 5, It adds about as much strength to the pavement as the ordinary concrete foundation. The objections to the cement filler are: 1, It causes the pavement to rumble when the vehicles are passing over it. The explanation for this rumbling is not satisfactorily explained, and the expansion joints do not entirely eliminate it. 2, It is very hard to tear up and repair the pavement, and the old brick are rendered almost useless. 3, After applying the filler, the pavement should stand from seven to ten days before traffic is admitted. This causes considerable inconvenience to the occupant of the property, especially in a business district. 4, It prevents the large brick from being settled in the sand cushion by the traffic, thus making the tractive resistance on pavements with cement filler greater than that of a sand filled pavement that has been used for awhile. 5, Considerable attention is required to see that the ingredients composing the filler are perfect and that it is properly applied.

Another filler for brick pavements is a No. 4, No. 5, or No. 6 coal tar distillate. No. 6 is the grade ordinarily used for this purpose. The tar is brought to the pavement in barrels heated in kettles to a temperature of 300 to 320° F., and poured into the joints from vessels with a small spout or from funnel-shaped cans. The cost of a tar filler is from 10 to 12 cts., depending on the locality of the pavement and the width of the joints. As long as this material remains in place, it keeps the brick in proper position, makes an impervious joint, and does not cause the pavement to rumble. The objectionable feature to the tar filler is that in the summer heat it melts and flows from the joints to the gutters, and there remains, making the pavement rough and hard to clean; and in the winter it becomes brittle, is chipped out of the joints by the horses' shoes, is ground into dust, and swept or blown away. In both instances the crevices are filled with droppings and dirt which are very inferior to sand as a filler.

Another filler, little used in the middle west until within the last year, which merits the attention of every city engineer, every property owner whose street is about to be paved, and every brick maker, is manufactured from genuine asphalt by the American Asphaltum & Rubber Co. The requirements this product shall meet as given out by this company, are as follows: "The asphalt shall not be less than 99.5% pure bitumen composed of not less than 68.3% petrolene, and 31.2% asphaltene (each having a specific gravity of not less than

0.90 and 1.13 respectively). The specific gravity of the compound shall not be less than 0.99. It shall not be 'tacky' after an exposure of five hours to a temperature of 125° F. The melting point shall not be les than 210° F., and by capillary tube tests, it shall not commence to melt below 195° F., and shall not run below 215° F. The filler shall remain ductile at all ordinary temperatures, and shall not be affected by the moisture."

The advantages of this asphalt filler are: 1, It keeps the brick in proper position. 2, It thoroughly protects the corners and edges of the brick. 3, It cannot be washed or swept out of the joints. 4, Water cannot penetrate it and reach the foundation. 5, It is thoroughly sanitary. 6, It adds about half as much strength to the pavement as the ordinary concrete foundation. 7, It does not run in summer, or become brittle in winter, and cannot be ground into dust, and at all times it remains flush with the surface of the brick, and prevents the wheels of the passing vehicles from jolting and rattling over the joints with a rumble and a roar. 8, It takes care of the expansion of the brick, and there is no rumbling sound. 9, Openings in the pavement can be more easily made and repaired than where a cement grout filler is used, and the asphalt can be removed from the brick with but little difficulty, be heated and used again in making repairs. 10, The pavement may be thrown open to traffic immediately after pouring the joints. On some streets the inconvenience caused by having the street blockaded for a week or ten days longer would amount to more than the additional cost of the filler.

At Bay City, Mich., is a pavement having the interstices filled with this asphalt. This work was completed in 1899, and on examination, the asphalt seemed to have retained all of its original properties, and could be worked into a ball without crumbling to pieces. The cost of this asphalt filler is about 14 to 16 cts. per sq. yd., which is about 12 to 14 cts. more than sand, and 4 to 6 cts. more than cement grout. If some expedient could be devised whereby a mixture of 1 part asphalt and 1 part sand could be poured and entirely fill the joints, excellent results could be obtained, and the cost would be very considerably reduced. But the extra expense of the asphalt filler is only a small item, and when its usefulness and the comforts which it affords are considered, the money is well invested.

EXPANSION JOINTS: Where cement grout filler is used, some expedient should be used to prevent the expansion, caused by the rise of temperature, from heaving the pavement or breaking off the curb where the sidewalks extend out to it. The rumbling noise, so common with this filler, has been attributed to this temperature expansion. However, in instances where the pavements are provided with tar expansion joints, the rumbling is still present, and right at the joints. From this we must conclude that the rumbling is from some other cause or the material used in the expansion joints does not possess sufficient elasticity. It has been the common practice to use No. 4, No. 5, or No. 6 coal tar distillate in the expansion joints. The asphalt filler already described has been used for expansion joints and with very excellent results.

WOOD BLOCK PAVEMENTSS Wood pavements, (not the round cedar block), seem to be growing somewhat in favor. The wearing surface is laid of rectangular wooden blocks, 3, 3½ or 4 ins. in depth, and set on end. The process of preparing the material consists of sawing the lumber into blocks, and after careful inspection, they are placed loosely in iron cages which are run into a large steel cylinder which is hermetically sealed. The blocks are gradually heated to a point where the moisture in the wood is transformed into vapor and removed by vacuum pumps. Kreodone oil or similar preservative is then admitted into the tank, and forced into the fibres of the wood under a pressure of 70 lbs. per sq. in., until each cubic foot has absorbed from 10 to 12 lbs. of the oil.

The construction of wood block pavements is very similar to that of brick, and the interstices between the block should be filled with sand, cement grout, or preferably, the asphaltic filler. When sand or cement grout is used as the filler, asphaltum expansion joints should be provided to prevent the pavement from heaving or rumbling. The advantages of this form of pavement are: 1, It is easily cleaned, maintained and repaired. 2, It is comparatively noiseless. 3, It is thoroughly sanitary. 4, It is durable.

A good example of this pavement may be seen on Michigan Ave., Chicago, in front of the Auditorium Hotel, and also on the Rush St. bridge. The blocks in these two instances were laid in June, 1900, have been in about five years, and have stood up well under the traffic. This is more than can be said of some of the pavements that have been laid in this city since that time. The cost of wood block pavements laid on a good concrete foundation is between 60 cts. and $1.25 more per sq. yd. than brick pavements, depending upon the depth of the surface block, and the location of the pavement. While it is more expensive than brick, the additional expenditure is for a luxury for which some property owners are willing to pay.

LOCAL IMPROVEMENT LAWS: The municipal local improvement laws are very lame, and in some recently constructed work, the contractor is left to the will and mercy of the property owner. For cities under 10,000 inhabitants, the improvement laws are very stringent in requiring the signature of the majority of the resident property owners affected to the petition. This requirement defeats the paving of cross streets on which some of the assessable property does not face. Another feature in the law is the prohibiting of alternative clauses in the specifications, which shuts out competition in certain materials. Efforts are to be made to have the old law repealed, and new legislation enacted, which will be more favorable to municipal improvements. Should any members of this Society, either as individuals or as its representatives, be called upon to aid in this work, it is to be hoped they will give it their hearty co-operation.

GOOD ROADS: The governor of this State in his inaugural address made mention of the unimproved condition of the public highway and the increasing needs for better roads. The State is spending large sums of money for agricultural experiments, investigations and surveys with excellent results. A kindred subject, or better perhaps, a branch of this great work, is a treatment for roads, and money for experiments and their study should be appropriated by the State.

O. L. GEARHART, I. O. BAKER, F. L. HANCOCK.

DISCUSSION ON PAVING.

MR. MAIN: At Rockford, a year ago, we put in a block of brick pavement on macadam foundation; it has given good satisfaction and I like it better than concrete. We shaped the street up just as if we were going to leave it for a plain macadam road, and rolled it with a 17-ton roller, and put a top dressing on; in fact drove on it for a few days. Then we laid the brick on a 2-in. cushion of sand.

MR. PROUT: I might give the experience that Elgin had in regard to some asphalt pavements last year. In the summer of 1903 the contract was let to the Federal Asphalt Co., which laid what was known as Kentucky rock asphalt. It was a miserable failure. The foundation was all right, though, and this year we have had that recoated with a California (Obispo) bitumen, and that so far seems to be a good job. I believe that wooden blocks, treated in that manner, as described in the report, would be a fine thing for bridges where the question of weight is a special object.

MR. MAIN: We used a cement filler with an expansion joint of tar and sand mixed, about the same proportion we would for a tar sidewalk, and it has not given us a bit of trouble in regard to running. They heat the tar as near boiling as possible, and then mix it just so it will be thoroughly saturated. We have a peculiar sand out there; it is only fit for tar work, but seems to hold the tar much better than any other sand, better than sharp sand. We made this joint every 24 ft. We use common tar from the gas works, with a very little pitch.

MR. GEARHART: We had a little experience at Champaign with tar joints. We had about ½-in. to ¾-in. joints, and now the tar is in the gutter. It was what is known as No. 6 pitch.

MR. ENNIS: In Montreal some years ago a local brick was to be used called the Prairie brick, a pervious brick. In some instances we used a cement grit filler, and in another instance we used an asphalt filler. The street was badly cut up with trenches, and the foundation was very bad. I had occasion to view the streets a year or so after, and where we used the cement grit, some of these trenches had gone down and settled, and the bond in the brick had totally disappeared. Where I used the bituminous filler, the depression was noticeable, but the joints were intact, owing to the pliability of this filler. In digging up those depressions, I noticed that where the cement filler was used considerable seepage reached the foundation; but where the bituminous asphaltum filler was used, the sand was as clean as when laid. I believe a flexible joint in street paving material is preferable to something that is solid.

MR. NICOLLET: In connection with broken stone foundation for brick paving one of the most important things to take care of is to be sure that the voids in the broken stone are thoroughly filled. I know of some brick pavement that was laid on such a foundation, where the broken stone was crusher run, without any special provision being made to fill the voids. In time of storm, the limestone screenings used for the cushion coat were washed down into the voids of the stone and gave the surface of the pavement a very wavy appearance after being in use several years. Whether wetting the sand is the best plan or not is a little questionable in my mind, from the fact that the earth must become thoroughly saturated, which may result in some unevenness; however, the advantages gained are probably much in excess of any detriment on that account. I believe that is one point that is very often overlooked in placing macadam foundations.

THE PRESIDENT: The bitulithic people set a great deal of store on the proper gradation of the stone, so that voids are filled for this very reason, and if I remember right, they claim to have the gradation such that the voids are reduced to 10% or 15% under the most favorable circumstances.

MR. TRATMAN: In reply to enquiry on this question of bitulithic pavement, I have the following information from the Warren company:

> In making a mixture of the several sizes of stone for the bitulithic pavement, the voids are reduced to between 8% and 11%, generally nearer the former than the latter. Some stones, however, break in a peculiar way in crushing, so that we are not able to get as low voids as in some others. An asphalt sand used in laying the Trinidad asphalt pavement has about 27% of voids, and ordinary crushed stone about 40%. The actual weight of the mineral aggregate in our paving mixture is 92% of the weight of solid stone. The voids above referred to in the bitulithic pavement are absolutely filled, as we put in more bulk of bitumen than would fill the 8% to 10% spaces.

MR. A. C. SCHRADER: In connection with the boulevards we find that upon those portions of street intersections where there is a curved track it seems next to impossible to hold the pavement for any considerable length of time, except it is the very best granite block pavement. Asphalt certainly will not hold, and so far as I know, even vitrified brick (such as we find in this part, at least) is comparatively short lived. In the use of granite blocks the width that should be used is not that usually laid down in this city, which is only about two or three lines of granite blocks, being about 12 to 18 inches in width. The curvature being of short radius, it requires a further extension of what you call the granite brow, which should be at least three or four feet in width, and outside the rail, that is, the outer edge of the curve and the inner edge.

SEWERAGE AND DRAINAGE SYSTEMS OF WHEATON, ILL.

BY W. B. EWING (CONSULTING ENGINEER).

The city of Wheaton covers an area of about 4 square miles and has a population of approximately 3,000 people. A great portion of the city lies north of the Chicago & Northwestern Ry. on slightly rising and rolling ground. That portion south of the railway falls gently to about half a mile to the south. The city drains through a ditch leading to the southwest. Aside from a small feed mill, a planing mill and a small laundry there are no manufacturing industries in the town, it being generally considered a city of suburban residences.

The absence of any defined plan of sewerage or drainage had been felt for some time and after considerable discussion and investigation by the municipal authorities, Mr. W. H. Tarrant was engaged to prepare general plans and specifications for a complete system of sewerage and drainage, including a septic tank similar to the one in Champaign. Upon securing a sufficient number of petitions, separate ordinances were prepared for a system of sewerage and also a system of drains, to be constructed under a separate ordinance for each system, which after some modifications of the general plans were passed and proceedings were taken for levying a special assessment for the construction of the system. The ordinances provided for purchase of condemnation of strips of land across various private properties for the purpose of laying drains and sewers. Owing to the depth of the sewers and drains at a number of places, the ordinances also provided for extending the Y's by 6-in. pipe to within 5 ft. of the surface. This required 1,106 ft. of pipe for the sewerage system. The work provided for in the special assessment for sewerage included 60,381 ft. of trench, 2 to 18 ft. deep, and 60,381 ft. of pipe, 8 to 15 ins. diameter, with 1,469 Y branches, 28 flush tanks, 94 man holes, 40 lamp holes and a septic tank. The ordinance for the system of drains comprised 55,242 ft. of trenching, 2 to 14 ft. cut, and 55,528 ft. of 6-in. to 33-in. pipe, 103 man holes and one concrete outlet abutment.

The writer's connection with the above began with the spreading of the special assessment. It was quite an interesting problem to meet the legal requirements of a fair and impartial assessment on account of a large number of irregularly shaped pieces of property lying in the assessed district. It was found on examination that the greatest of any one kind or shape of property was a lot 66 ft. front by 132 ft. deep. In making up the assessments this was taken as a basis and called 66 units. A lot measuring 66x165 ft. was assessed a proportionate number of units, and one 66x198 ft. a still greater number of units. This was the basis of the assessment on the property immediately fronting on the line of the improvements. Property not immediately touching the proposed improvements but lying in the district, was assessed that proportion of the full assessment determined by the difference between the cost of such additional improvements as would be necessary to place the property directly in connection with the present system and the assessment of the same or similar property adjacent to the improvement.

This same principle was adhered to throughout the entire assessment for determining the units for each piece of property. The rate per unit was then the quotient of entire amount assessed divided by the sum of all the units, which rate multiplied by the number of units assessed to each piece of property determined the amount of the assessment. This arrangement was found to be very satisfactory and stood the test of a number of objectors, who appeared in court to seek to reduce their assessment.

The contract for the sewers was awarded to the lowest bidder, J. H. Green & Sons, of Appleton, Wis. The contract for the drains was awarded to Charles M. Porter, of Maywood, Ill., but afterwards assigned to Green & Sons, who did the entire work. The prices were as follows:

SEWERS—Pipe, delivered and laid; from 14 cts. for 6-in. to 54 cts. for 15-in. Trenching and back-filling; from 13 cts. for 2 to 4 ft. cut, to 45 cts. for 16 to 18 ft. cut. Manholes, $50; lamp-holes, $10; flush tanks, $60. septic tank, $3,500.

DRAINS—Pipe, delivered and laid, from 20 cts. for 6-in. to $3.25 for 33-in. Trenching and back-filling; from 30 cts. for 2 to 4 ft. cut, to $1.10 for 12 to 14 ft. cut. Outlet abutment, $50. Catchbasin, $30.

The septic tank was constructed of concrete. The inlet valves and also the valves leading to the sludge well were 15-in. Coffin shear valves. The weir at the outlet is constructed of 6x6 in. angle iron imbedded in concrete. The drain pipes were being laid with butt joints without cement; where thin silt or mud was encountered, the joints were filled with oakum loosely caulked. The work was somewhat remarkable on account of constructing both entire systems in one season.

At one time, in addition to several gangs of workmen, four excavating or trenching machines were employed in this work. One machine, not able to make a showing, was abandoned. Another was the Dalton machine, which consisted of a wheel about 13 ft. diameter, with six arms extending about a foot beyond the rim of the wheel. To these arms were attached small pieces of ½-in. soft steel, about 8 ins. long and 4 ins. wide, for the purpose of cutting loose the earth in the trenches. Immediately following these knives was a heavy iron bucket about 1 ft. square and 14 ins. deep. This bucket followed the knives around through the trench and revolved with the wheel. On reaching the top of the circle the arm, to which the bucket was attached, was released and the bucket turned out to one side in such a manner as to empty the contents along the side of the trench. The wheel revolved so as to cut toward the machine. The machine was mounted on wheels and pulled the cutting wheel close up to the work and itself along the line of the trench by means of a cable fastened to a deadman some distance away and winding around a slowly revolving drum. In 22 miles of work, this machine excavated about 30,000 cu. ft. Its average rate varied from 250 ft. in hard, stony ground to 400 ft. in a trench 7 ft. deep and 20 in. wide in soft ground.

The other two machines used in this work were known as Chicago excavators. The machine consists of an arm constructed of angle irons thoroughly braced and of sufficient length to reach from the machinery to the bottom of the trench. Along this arm are a number of rollers, and at its end is a sprocket wheel. A double endless line belt or chain carrying a series of cutters and scrapers extends from a sprocket wheel at the engine down around the end of the arm and back again. Upon lowering the arm to the ground and revolving the belt toward the machine, the cutters loosen the earth, which is drawn up to the top of the trench by the scrapers back of the knives and delivered to a horizontal belt conveyor, running at right angles to the machine, which belt discharges the excavated material along the side of the trench. The machine is pulled ahead of the trench by a wire cable fastened to a deadman of two 6-in. pipes sunk in the ground, and the cable slowly wound on a drum on the machine. This machine was quite successful in excavating and in heavy work has cut a trench 30 ins. wide and from 15 to 18 feet in depth. In this trench the average progress per day was from 150 to 200 ft., depending upon how much bracing was necessary. Under lighter work this machine has excavated 750 ft. of trench 30 ins. wide and 7 ft. deep, through a hard clay and mixed with small stone.

Most of the back filling was done by team and scrapers. The surplus earth was drawn away in wagons and later the streets were gone over with a road grader.

The pipes were laid to a true line and grade. Before excavating, a line of stakes 25 ft. apart were placed about 4 ft. from the center line of the trench and on them marked the cut below the marks on the stake. From the marks on the stakes, cross pieces were laid horizontally across the trench, and a line stretched from one cross piece to the next. The line and grade of the sewer or drain were fixed by measuring from grade line.

The sewers were usually placed in the center of the street. The drains were usually 10 ft. north or west of the center line of the street. At each street intersection, the lines of the sewers and drains crossed each other. To avoid confusion and to prevent the sewers and drains from intersecting each other, the sewer grades were first fixed and then transferred to the drain profile, whose grades were then laid so as to pass over or under the sewers.

Work was begun about May 25, and the entire work completed on Nov. 30, 1904.

The contractor's estimates were paid in cash raised by selling special assessment bonds from time to time in amounts varying with the amount of the estimates.

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REPORT OF THE COMMITTEE ON SEWERAGE.

The work accomplished in Chicago during the past two years has been confined to the extension of existing sewerage districts and the designing of systems for two new districts in the southern part of the city, where owing to the fact that its natural surface is but from 6 to 12 ft. above the level of Lake Michigan, it has not been possible to maintain gravity sewers. In the two districts lately established, one of which is known as the Jackson Park district, covering some 6,200 acres of territory, the sewage and drainage water is to be elevated by pumps and discharged into the south branch of the intercepting sewer system of the city. This system will cost in the neighborhood of $1,000,000 and the contract for a portion of it has been let and the work is under progress. The main sewer leading to the pumping station is 11 ft. diameter, laid to a grade of 0.04%, giving a capacity of some 430 cu. ft. per second. The other district is known as the 95th St. district and the sewage is raised 12 to 14 ft. by pumps and discharged into the Calumet river. The district comprises 5,500 acres; the main sewer is 10.5 ft. diameter on a grade of 0.04%, with a capacity of 380 cu. ft. per second. In both of these cases the design has been based upon a population of 50 persons per acre and 130 gallons per capita, with an additional amount of 1,000 gallons per acre for seepage for sand soil, and 500 gallons per acre in clay soil. The sewers are provided with a capacity for double this quantity for ordinary storms and 3½ times for maximum storms giving approximately 0.022, 0.044 and 0.077 cu. ft. per second per acre respectively. A description of the power plant and its arrangement as designed for the Jackson Park district will be found in the Engineering News, March 31, 1904.

These sewers are built by special assessment and have been designed by Mr. C. D. Hill, engineer for the Board of Local Improvements. A paper by him is published in the "Journal" of the Western Society of Engineers, Vol. VII, page 425. Following this article is a discussion of its different features by Chicago engineers which makes the article valuable to the sanitary engineer having to design sewers for large areas. In connection with this, it is well to mention an article read before the same Society on the "Excessive Precepitation of Rain at Chicago," by Edwin Duryea, and published in Vol. IV, of the same Journal, on page 73. An interesting discussion follows this article also.

Besides the work done by the special assessment department, the city has been quietly completing the immense trunk sewers of the intercepting sewer scheme which is eventually to exclude all the sewers from Lake Michigan and discharge it into the new drainage canal. This work is under the care of Mr. W. S. MacHarg, consulting engineer. It is described in the "Journal" of the Western Society of Engineers for February, 1905, and in "Engineering News" of May 28, 1903. During the past two years much of the work of constructing these intercepting sewers has been done by day labor under civil service rules.

During the past two years, the State Legislature has passed bills annexing two large territories to the Chicago Sanitary District; the Evanston district on the north and the Calumet disrict on the south. The engineers of the Board have been at work designing channels to relieve this additional territory and the general location of canals both north and south, has been determined upon. This location has opened up the problem of utilizing these channels by the various municipalities through which they pass, and partially along the north shore there is a deep interest manifested among the property owners to know just how they are going to be benefited by the extensions. At present the north shore towns are discharging their sewage into Lake Michigan, from which their water supply is derived, and they are beginning to realize that some permanent solution must be made of the sewage disposal question. This year is likely to see a more systematic study of the situation and perhaps plans outlined by which these municipalities can protect their water supply from their own polution. It appears strange that the people of the north shore should allow their property to be annexed to a taxing district like the Sanitary District of Chicago without first even inquiring what it meant to them and how they were to be benefited for the taxes which they are called upon to pay.

Another important feature of this branch of engineering is the disposal of sewage, and reviewing the progress of the past two years in this line, we find a steady advance, although still but few works of any considerable importance have been constructed. It is probable that a larger number of septic tanks have been constructed in Illinois (including public and private works) than in any other State, and it is also probable that better results have been obtained therefrom as a whole. It is generally admitted by engineers who have been studying the progress of the art, that the septic tanks in themselves, are not adequate means of purifying where a high degree of purity are required, but that some other form of treatment must be added where the effluent is not discharged into a large body of running water.

Those of us who have been following closely the recent practice, both in England and America, find a very wide divergence of opinions and practice in the design and construction of works for the final treatment of the tank effluent. At the present time here in America, and particularly in the eastern states, the contact beds prevail; during the past year, however, considerable attention has been called to the percolating filter so called, and present indications are that it will find many advocates under favorable conditions. A filter of this type was completed in the early part of 1903 at Milwaukee, Wis., a description of which appears in last year's proceedings of the Indiana

Engineering Society. The operation of this plant for the past year has been such as to warrant engineers in adopting this type under like conditions where sufficient fall is available. In a great majority of cases, however, the engineer is limited to an available fall which will not admit the use of this type of construction and in many cases even the contact bed is not permissible on this account. Sand filters intermittently operated have proved adequate to produce a satisfactory degree of purification where they have been operated with a reasonable amount of care and skill, and it is doubtful whether any of the present new methods of filtration will be able to excell the sand filters when properly constructed.

In connection with the septic tank, those who have been reading descriptions of English plants where anaerobic filters have been used, might be interested to know that in the Allis-Chalmers plant at Milwaukee, before referred to, an anaerobic filter of this kind is employed. At Highland Park, Ill., also where a septic tank was recently installed, a secondary tank or compartment is in use; here the effluent from the tank proper has a low drop into the secondary tank which is constructed after the principle of the anaerobic filter but without the filtering media.

Among the sewage purification works in Illinois, we mention the following towns where septic tanks are in use: La Grange, Wheaton, De Kalb, Princeton, Kewanee, Monmouth, Macomb, Champaign, Glencoe, Highland Park and Lake Forest. Besides these there have been many other installations, none of which are very extensive, but many are successful and interesting as a solution of the disposal of sewage from isolated residences, schools, institutions and factories. Aside from the use of the septic tank as above mentioned, the city of Lake Forest has installed a system of sand filters wherein the tank effluent is treated by an intermittent filtration. The village of Glencoe has installed the Cameron system of double contact beds, and at Mendota, there is a system of intermittent filtration without the use of the septic tank. Plans have also been prepared for works at Bellville, Centralia, Galesburg, Galva, Polo, Marengo, Naperville, Downers Grove, Chicago Heights and Highwood. The new book of M. N. Baker, entitled "British Sewage Works," describes a large number of English plants which have been constructed within the past six years upon the "bacterial processes." The description of the Ohio plants as given by Mr. R. Winthrop Pratt, state engineer, in the advance sheets of the report of the Ohio State Board of Health for the year 1903, is of perhaps equal value, as it gives the results of chemical analyses of the different plants described, as well as pictures of the plants and in some cases copies of the plans.

In this connection also, it might be proper to state that suits have been begun in the U. S. Circuit Court by the Cameron Septic Tank Co. against several cities, among which are Macomb, Monmouth and Lake Forest, for infringement of patents granted them by the United States on septic tanks. This is an important case to engineers and people in general, and it is sincerely hoped that an early decision will be made upon the legality of these claims.

Another important matter in connection with this subject of sewerage is the status of our state laws covering the making of special assessments for sewerage improvements. We have laws authorizing the construction of sewage purification works, but they are so drawn that it is of little value to the municipalities already provided with sewers, but with no adequate outlet or disposal works, in that it requires a petition from the majority of property owners affected by that improvement, which is practically impossible in large districts. The amendment to our laws purporting to do away with the petition feature has now been declared unconstitutional by the Supreme Court, but not until after quite a number of cities taking advantage of the amendment, had begun proceedings in court for special assessment covering the cost of such works, and some of them had even gone so far as to have their work completed and bonds issued. It is unfortunate for the sanitary interests of our cities, that our laws cannot be so amended that proper means may be adopted by municipalities to raise funds to construct sewage disposal works, when the necessity for such works have been established and plans therefore been approved by proper state officials.

W. S. SHIELDS, F. M. CONNOLLY, H. A. STEVENS.

DISCUSSION ON SEWERAGE.

Mr. Ewing: Regarding the trenching machine, I had occasion a little later to lay about 10 miles of water mains at Grossdale, Illinois. On that work the Dalton machine was used, and the average cutting on a trench 5 ft. deep was about 300 ft. a day. At the time of laying this water pipe, however, the Municipal Engineering & Contracting Co. placed on the market a machine designed specially for excavating for small water pipes, and slightly differing from its larger machine. It was quite compact, and very light, with an arm that extended into the trench and carrying knives, taking out a trench 13 or 14 ins. wide. In hard, firm earth, with not too great a quantity of small stones, it was able to make from 700 to 1,000 lin. ft. per day of 10 hours. Where the small stones were present in great number, the work was delayed to a considerable extent by the stones wedging between the links of the chain and the sprockets on the wheels, which required close attention to prevent choking down or breaking the chain. We caulked every other joint in the ditch, where the pipe was not over 8 ins. diameter. The bell holes were dug by hand. When gas connections and other obstructions of that sort were found in the trench, the leg of the machine was simply lifted up and passed over them and that portion was taken out by hand. Sometimes we struck the pipe before we had any intimation it was there, but the contractor usually went ahead and located the connections and disconnected them. When the machine had passed the pipes were connected up again. It was much cheaper to do that, on account of the radius of this leg being about 20 ft. long and swinging from the center it made quite a circle there that had to be dug out by hand.

There is no considerable saving in trenching for water pipe by a machine at present prices. I understand the policy of the company is to rent the machines to the contractors at a price (for excavating for water pipe) of $20 per day, and an additional bonus price of 5 cts. a yard for excavated material. The company furnishes the operator, the contractor furnishes the coal. Practically one man runs the machine. I don't know that there is a great deal of profit in it, but it is the speed. I believe the cost is about the same as excavation by hand, but the speed can practically be doubled. We laid 10 miles of water mains in Grossdale in 40 days with one gang of 50 Italians and two excavating machines. For heavy work, there is considerable advantage in using machinery if the ground is firm, but I would not advise anyone to bid low with the idea of using it. In soft, moving ground, you are liable to get into trouble with the machine and probably have to excavate it frequently.

Mr. Schmeltzer: In Kankakee County we have had considerable experience this summer with the Buckeye traction ditcher in laying tile drains. The only real difficulty they seemed to meet was the soft ground. We had two machines and the larger one cut a ditch 28 ins. wide and nearly 8 ft. deep. Rock and soft ground are the only things that hold this machine back, and it did very much more work in a day than the amount mentioned in the paper. In a 5-ft. cut in three different day's work with the large machine they cut and laid the tile in 70 rods a day. In the 18-in. tile, in a week's work, they averaged 50 rods a day for six days in succession. It was practically 5-ft. work. They can keep their grade, as they follow a survey very rapidly. They have a side arm cutter wheel and they set two to four targets ahead so as to bring three points in the line. They set those targets the same height above the grade line as the arm on the cutter wheel. Then, by turning a wheel, they can hold that. Small stone about the size of a man's head cut very little figure; the larger ones, however, do cause considerable trouble.

The repair bills in some particulars are a little heavy; that is where they are striking rock occasionally. If it is earth only, the repair bill is not so very large. The machine works rapidly and is easily controlled. The list price of the large machine is about $4,000. I do not know what the discounts are. Of seven districts, one will probably issue bonds; those were sold by the municipality. They were 5% bonds, payable at par. The assessment was payable in five installments.

MR. PROUT: Perhaps every municipality has not the advantage of as accommodating a mayor as at Wheaton, and it was through his efforts partly that the scheme was financed. The city did not issue any more bonds than were absolutely necessary to take care of the amount, over and above the amount of money that was provided by the mayor and his friends. That, perhaps, is one reason why we were so well able to take care of the bonds for the whole job.

MR. TRATMAN: I would like to say a word as to the way in which the back filling was done in those trenches. In all the work I saw there was not a drop of water put in and there was no tamping done around the pipes. They simply took a horse and scraper on the top and scraped the dirt loosely into the trench. As to the use of scrapers for leveling off the surface, that may have been done on some streets, but others were left with high ridges of dirt in the middle which have remained all winter.

MR. MAURY: The earth from trenches can be put back even a little more solid than it was before they were excavated. A very praiseworthy practice was started in Peoria of requiring contractors to tamp the ditches back and for excavation in the city we always allow from two or three times as much for back filling as we do for excavation, because they get so many tampers to every shoveller that on a trench where we can excavate a foot of ground for 7 cts. a lineal foot, we have to figure from 14 cts. to 21 cts. for the back filling. But while the cost to us for excavation is three or four times what it ordinarily would be we believe that the regulation is an eminently wise one, and we cheerfully agree to the extra expense. The only thing that we would like to see done always, and it is usually done now, though it didn't use to be, is that the requirement should be equally enforced on all companies opening the streets.

MR. EWING: As to the assessment, my recollection is that the price was $44 for a 66-ft. lot; and very close to the same amount for the trenches. In regard to the criticism I will say that the ditches were usually very freely watered. The city had practically no improved streets. The reason the earth over the trenches is abnormally high in some places is because they were left under an agreement with the street commissioner.

MR. TRATMAN: The fact that the backfilling was not properly done (water or no water) is shown by the way in which the filling has sunk; in some places going down bodily for a depth of a foot or so and leaving an open trench.

MR. MCCLANAHAN: We installed a septic tank in Monmouth that was completed in June, 1903. It is 70x105 ft., and 7½ ft. deep, in two compartments. Our trouble in Monmouth is that our system is combined. Therefore we have to contend with the storm water, and it is utterly impossible to build a tank large enough to care for that. Therefore I had to put in a storm water separating box, with an automatic door separating the storm water from sewage in the bottom part of box. Then I had a 12-in. pipe, which is sufficient to take the natural flow of the water, under fair, ordinary circumstances, leaving all that was over that for storm water. When the pressure becomes great enough in the storm water box, it opens the door and the storm water goes immediately out into the stream. The sewage proper I delivered through a pipe 150 ft. in length from the storm water box to the septic tank.

I emptied the tank after it had been in operation for about three months to test the amount of inorganic matter in the bottom of the tank and I found that at the outlet there was really nothing not over ¼-in. But at the outlet we are bothered now with the sand that has been washed in from the streets. In the building of my tank I put in intercepting walls crosswise, which compels the water, after entering the tank in the 105-ft. building, to travel 208 ft. before reaching the exit, and there the top of the effluent is never moved; it is not allowed to get away. The effluent is removed about 22 ins. below the top, so that the top remains very quiet. The water from the tank, after passing the 208 ft., enters into an apartment of its own, which is two feet above the bottom that is in the main tank, and there rises to top of main tank. Here it passes out into a spray box and is thrown off over sprays the whole length of the end of the tank, and from that passes right down into a tile and is carried 500 ft. from the end of the tank, where it empties into the stream again. Before we put this tank in the city was sued for damages because stock would not use water from the stream below. It had become a nuisance. Since we have had the tank running, we have had the most favorable accounts of all the effluent that passes from the tank.

It has been stated that the Cameron Septic Tank Co. has started suit against us for infringement. Their engineer was there two days, spent the day at the tank, and the next day in my office examining the plans. He did not get down into the tank and does not know anything about what is in there. Their patent, as I understand it, is on the submerged inlet and also a submerged outlet; my inlet is an over-let and my outlet is an over-let or spray outlet. Passing through the tank is where I claim we have the advantage of the purifying of the water. The matter that is in the bottom is entirely inorganic; there is no life in it; you cannot disintegrate it; you cannot burn it; there is nothing in it at all that has anything that could be disposed of.

The tank itself cost $7,300. The tank, with the storm water separating box and the connecting sewers built out 2,000 ft.; 1,100 ft. of 30-in. brick sewer, and 1,100 ft. of 36-in. pipe sewer, and 850 ft. of 49-in. block sewer, cost $14,853; the cost of the care of it since it was put there is $1 every two weeks. In order to keep as much of the silt and matter of that kind out of the tank as possible, I put a screen around the pipe that leads out of the storm water box into the septic tank, and that will coat and seal and I have to have a man attend to that once every two weeks. It costs therefore, $2 a month to run the concern. It is all gravitation, no pumping. But the fall on the last 2,000 ft. was very slight; it was only 8 ins. on the last 850 ft., and 11 ins. above that, so that as a matter of course, during heavy storms it makes that 49-in. sewer a reservoir. It also makes the 36-in. sewer a resorvoir. We have 27 miles of sewer going into that one tank. It is a system quite my own from the very beginning, but I do not think I would recommend the combined system for any city. I think if we had a separate system we could do with a much smaller tank than we have, and would get the effluent in just as good shape.

MR. EWING: The La Grange tank was also in trouble at one time. The sewerage is on the combined system. The town lies on the first rise above the level plain near the lake. The elevation of the higher portions of the town, at the south end, is about 72 feet above Lake Michigan, and falls to an elevation of about 68 ft. at about ½ or ¾-mile to the north. The eastern portion of the town is on practically a level tract of ground, at an elevation of 48 ft. above Lake Michigan. It is about two miles from a small creek known as Salt Creek, which empties into the Desplaines river in the vicinity of Riverside, about ½ mile below the point of discharge of the La Grange sewer into Salt Creek. The main sewer or outlet extends east and west practically through the center of the town, and runs to the eastern limits of the town and then runs north about 800 ft. to its intersection with Ogden Ave. This is a brick sewer, 6 ft. diameter.

At the intersection with Ogden Ave. it connects with a rectangular box sewer constructed of two thicknesses of plank, 4 ft. high and 8 ft. wide, with a partition through the middle to support the top.

The object of constructing a septic tank was to relieve, as far as we could, the conditions during low water in Salt Creek. The sewage after passing through the wooden box sewer for a distance of about 4,000 ft., running eastward along Ogden Ave., runs in an open ditch for about a mile, when it empties into Salt Creek. Salt Creek is rather susceptible to the rainfall there, and has corresponding intermittent periods of high and low water. During the period of extremely low water in the summer months, the bottom of Salt Creek is practically a series of shallow pools, varying from 6 to 24 ins. deep. The sewage discharging into the creek fermented to a considerable extent, which produced conditions quite obnoxious and resulted in several lawsuits in which up to the present time, the village has been able to maintain its position. The history of this will probably be a little interesting. La Grange was troubled with the disposal of its sewage for years. The first scheme adopted, after considerable discussion, was to extend the outlet southward along the line of the right of way of the Chicago Junction Ry., and discharging into the Desplaines river. I designed an outlet sewer which was to be constructed in rather a peculiar way. From about 400 ft. from the south limits of the village, for a distance of three miles, the rock is from 12 to 24 ins. below the surface of the ground, and the scheme was to cut a rectangular channel through the rock and cover it with a segmental concrete arch, the sides to be smooth and open, permitting the drainage from the surrounding country to run in through the interstices in the rock. To finance it, a special assessment extending over the entire territory of the village was started, and while it was endorsed to a large extent, it met with some opposition, and the scheme was finally abandoned. Later the septic tank was constructed.

We have a combined system, and in order to control the flow of the tank, and to avoid the necessity of running the storm water through, which would require a tank of excessive size, a small intersecting dam was built in the outlet sewer at the brow of the hill. A conduit of 12-in. sewer pipe was inserted in the dam, bringing the flow line of the tank about 1 ft. above the surface of the ground, at the outlet. The tank was located at the eastern extremity of the village thirteen hundred feet away from the intercepting dam. The conduit being entirely underground and the flow line of the tank being above ground, the sewage after leaving the hill, was under a head of about 4 ft. in the conduit.

In laying this conduit we used pipe 30 ins. long, with corrugated spigots; the joints were tightly caulked with hemp yarn, and followed with neat cement moistened and pushed in with an iron chisel or caulking tool. The tank was constructed of concrete, and consisted of three longitudinal compartments 10 ft. wide, 100 ft. long and 10 ft. high, leaving a space of about 3 ft. above the flow line. The sewage was introduced in these three compartments about 2 ft. below the level of the flow line, through a 12-in. sewer pipe, provided with valve chambers and valves for regulating the flow or entirely shutting it off from any portion of the tank. At the outlet, a curtain of two thicknesses of matched boards was constructed, extending about 4 ft. below the surface of the water and about 4 ft. back from the outlet, so that the sewage in passing through the tank, entered through the submerged inlet, flowed through the tank and passed under this inverted weir, or curtain, and flowed out over a weir of angle iron, dropping about 18 ins. into an outfall basin which extends along the whole length of the front of the tank, sloping towards an outlet pipe about the center of the basin. This outlet pipe extends directly downward. The sewage is intercepted from the outlet sewer, through the tank, and discharged back into the outlet sewer and thence to the point of discharge at Salt Creek.

During periods of high water or excessive rain fall the flow in the main sewer rises 4 ft. above the intercepting dam. To prevent the storm water from affecting the tank, a slot was built in the valve chamber about 3 ins. above the flow line. The capacity of this slot is three times as great as that of the inlet pipes, so that during high water the surplus flows through the slot back into the main sewer.

In regard to the action of the tank, the effluent is usually clear, colorless, and odorless. Occasionally there is an odor, and occasionally high winds blowing across the thin film of the effluent that flows over the weirs, will blow an odor for say 100 ft. To prevent the disturbing of this film, the outlet was incased with glass. Since that time there has been no odor from the tank. Sometimes, for quite a period, the sewage at the outlet is free from odors, under other conditions there may be quite an odor. Whether it is from the tank effluent or not, I am unable to say, because a portion of Grossdale, as well as a small portion of La Grange, empties sewage into the outlet sewer below the junction of the tank. The flow from the outlet is not all sewage from the septic tank. The tank has been in operation about three years, during which time repeated soundings of the tank have been made but without detecting any deposit with a sounding rod. In July last the tank was drawn off; under the conditions existing at that time it was impossible to say just how much inorganic matter there was. I should judge the greater portion of the sediment showing was the scum that floated on the top, rather than the material on the bottom.

NEW WELL AND HYDRAULIC PUMPING PLANT AT PEORIA, ILL.

BY DABNEY H. MAURY (MEMBER).

Prior to the construction of the well and pumping plant to be described in this paper, the writer, as engineer for the Peoria Water Works Co., had already built for the company two hydraulic pumping plants. The earlier one, consisting of two duplicate pumping units installed in a well 3,340 ft. north of the main well, was completed in 1895, and was described in Engineering News, Jan. 13, 1898. The second plant, built in 1899, consisted of four hydraulic pumping units, each installed in a steel cylinder sunk by the pneumatic process in the bottom of the main well itself. For a description of the second plant, see Engineering News of April 26, 1900. These two plants served their purpose well, and nothing like a shortage has been experienced since their completion; but the large increase in consumption, due to the rapid growth of the city, made it advisable to provide still more water.

After all the available water-bearing gravel in the neighborhood had been carefully explored by test wells, it was decided to locate the new well at a point about 1,250 ft. almost due south of the main well. The natural surface of the ground at the well site was flat, its elevation being 31.50 Peoria city datum, and subject to overflow except at quite low water. Before beginning the actual construction of the plant, an embankment was built around the well site at elevation of 36, and a roadway at the same elevation was made from high ground to this embankment.

As in the case of the pumping units in the first two hydraulic plants already mentioned, the motive power in the new well (well No. 69), is water under pressure from the force main of the Worthington high duty stream pumps at the pumping station. This water operates a 30-in. Pelton water wheel, directly connected on vertical shaft to an 8-in. centrifugal pump. The pump delivers the water through a 20-in. wood stave pipe into the main well, while the motor water, after it has done its work, is not lost, but flows back by gravity to the main well through the same pipe. This arrangement is shown by the plan and profile in Fig. 1.

For conveying water under pressure to the Pelton wheel, an 8-in. steel pipe was laid. The pipe is what is known as line pipe, being slightly heavier than standard pipe, and good for working pressures of considerably over 500 lbs. This pipe was coated inside and out by dipping it, while hot, into mineral rubber heated to a temperature of about 450° F. in tanks built for the purpose. The pipe was laid with great care, and was bottle-tight under the pressure test. The pipe used to convey the water from the pump and the water from the motor back to the main well is 20 ins. inside diameter, built of wood staves with ½-in. steel bands, spaced 8 to 12 ins. apart ,and slopes toward the main well on a grade of 0.1 ft. to 100 ft. Where the depth of fill over the pipe exceeded 12 ft., it was surrounded by from 3 to 5 ins. of concrete.

The well, Fig. 2, consists of a steel strainer separated by a steel bulkhead from the pump pit or dry well, which is of brick masonry, and is surmounted by a small circular brick well house. The strainer, Figs 3 and 4, is 9 ft. diameter and 21.5 ft. long, built up of ⅝-in. steel plates, perforated with about 34,000 holes 11/16-in. diameter. These holes are arranged in groups, each group being covered by a rectangular ¼-in. plate, bent to fit closely to the inner surface of the ⅝-in. plates, and fastened thereto by cap screws removable from within, the joints being made water and air tight by rubber gaskets. Through the steel bulkhead extends the suction pipe, which is in one piece, and has no joint below the bulkhead. The bulkhead is also

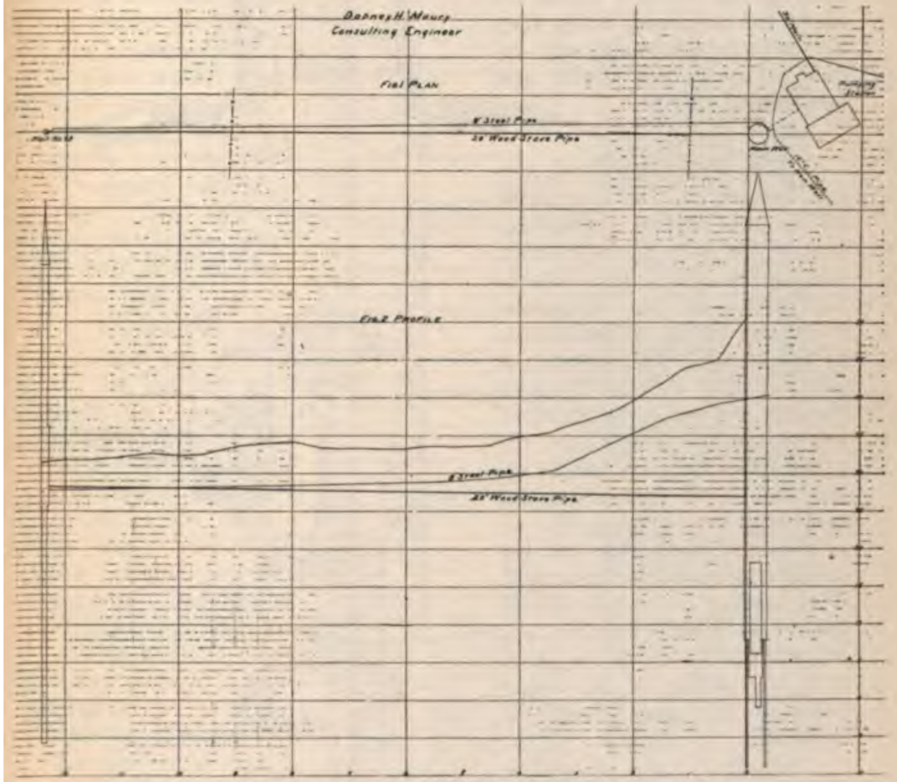


FIG. 1. PLAN AND PROFILE OF WELLS AND PIPE LINES.

provided with a manhole, opening into the strainer chamber. A 6-in. angle stiffens the cutting edge of the strainer, and a 3½x2½-in. angle was added to provide a support for the 40 tons of pig iron used to load the well in sinking. In the dry pump pit above the bulkhead, where they are always accessible, are located the Pelton wheel and centrifugal pump.

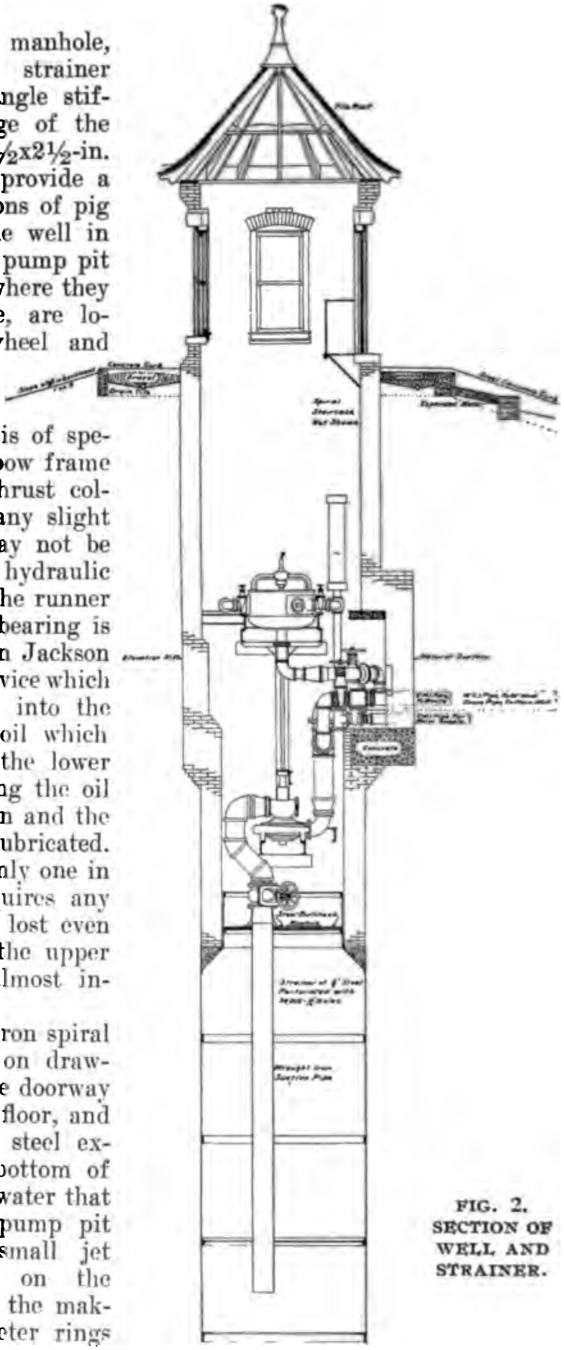


FIG. 2. SECTION OF WELL AND STRAINER.

The wheel case is of special design, and the bow frame on its top carries thrust collars which take up any slight end thrust which may not be eliminated by the hydraulic balancing device on the runner of the pump. This bearing is lubricated by a Byron Jackson vertical self-oiling device which automatically pumps into the upper reservoir the oil which has run down into the lower reservoir, thus keeping the oil in constant circulation and the shaft continuously lubricated. This bearing is the only one in the plant which requires any oil, and as no oil is lost even here, one filling of the upper reservoir will last almost indefinitely.

There is a cast iron spiral stairway not shown on drawings, leading from the doorway down to the grating floor, and a vertical ladder of steel extends down to the bottom of the pump pit. Any water that may leak into the pump pit is removed by a small jet pump, not shown on the plans. To facilitate the making of tests, piezometer rings are provided on the supply pipe of motor and the suction and discharge pipes of the pump. The $2\frac{1}{2}$-in. rings on the motor pipe are connected to pressure gages, the 8-in. ring on pump discharge pipe is connected to a glass water column, and the 8-in. ring on suction pipe is connected to a mercury vacuum gage. The 20-in. pipe discharges into a weir box at the main well.

The work of construction was begun in the summer of 1903, the pipe lines being started at their northern ends and built as far south as the stage of water over the low ground would permit. The steel strainer was delivered in sections, the lower section being sunk as far as possible in advance of the arrival of succeeding sections, each of which, as it came, was field-riveted to the preceding section. As the strainer went down, the masonry wall of the pump pit was built up on top of it. It was at first thought possible

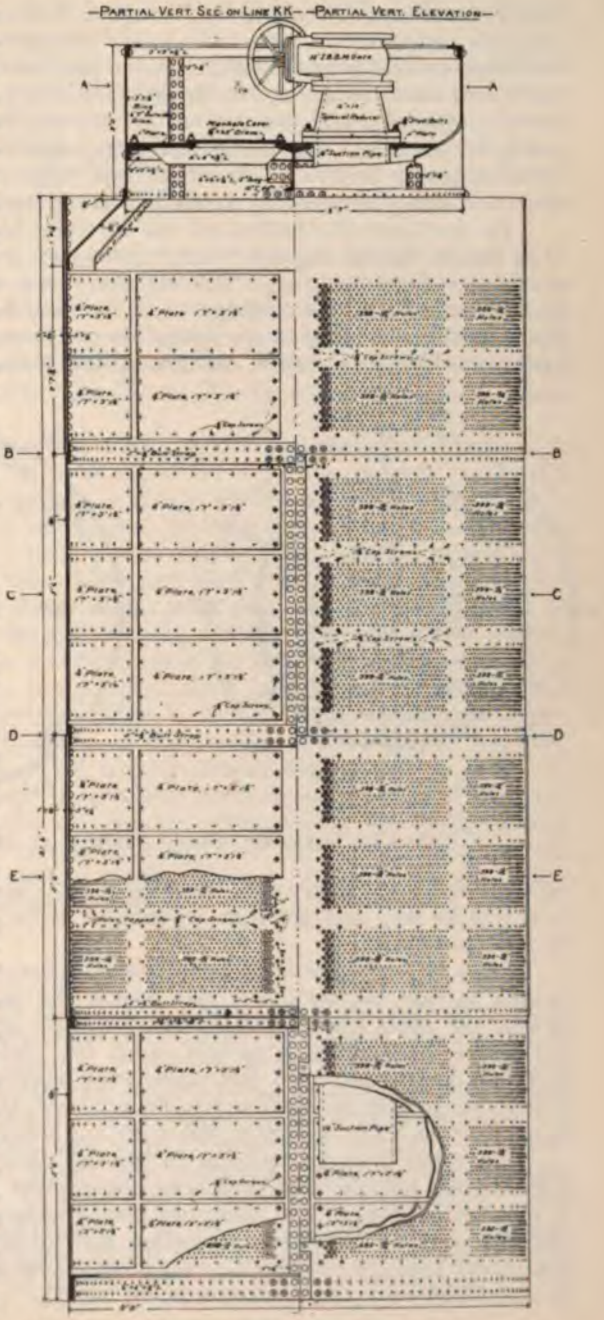


FIG. 3. ELEVATION AND SECTION OF STRAINER.

that the well could be sunk by the open, or pump-and-sink method, although arrangements were made to use the pneumatic process should the other method prove difficult. Work was interrupted several times in 1903 by small floods, and in December of that year the extreme high water compelled its abandonment till late in June of 1904, when it was again resumed. The centrifugal pump used in sinking was driven by water power from the 8-in. pressure pipe line, the coarser material excavated being removed by a small hoisting engine.

By the time the bottom of the strainer had reached elevation 11.0, Peoria datum, the water came in too fast for the sinking pump, which was then removed. The air shaft and air lock, which had been provided for this contingency, were then bolted on to the top flange of the strainer, an air compressor, driven by the same water power, was quickly installed, and the sinking proceeded at the average rate of 2 ft. per 24 hours until completed. The maximum air pressure used was 14 lbs., and the men experienced little or no inconvenience at this pressure.

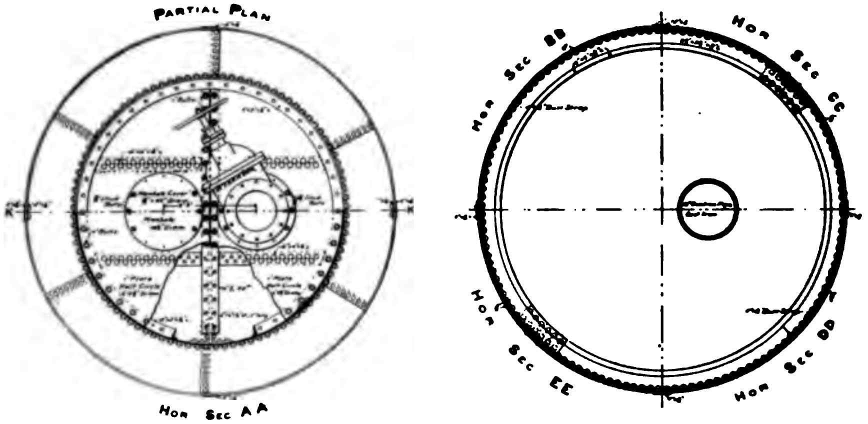


FIG. 4. PLAN AND CROSS SECTION OF STRAINER.

After the well had been sunk, the air pressure was kept on long enough to take off the ¼-in. plates from the inside of the strainer so that the water might flow in; to remove the pig iron used to load the well in sinking; and to bolt down the north half of the steel bulkhead which had been left open while sinking was in progress. The 12-in. gate on the suction pipe being closed, the air lock and shaft were removed, and the rest of the work was finished in the open air.

There has been no occasion to use the plant as yet, so that no definite tests for efficiency have been made under working conditions. A number of tests of the pumping plants installed in 1899 showed that the combined efficiency of Pelton motor, centrifugal pump and connecting shaft exceeded 50% over a considerable range of variation in speed and load, the miximum being 52.6%. It is hoped that the efficiency of the new plant installed in well No. 69 may equal or even slightly exceed these figures.

Assuming that the duty of the main steam pumping engines is 100,000,000 ft.-lbs. per 1,000 lbs. of commercially dry steam, and that the combined efficiency of the motor and pump is 50%, the net duty at the distant station would be 50,000,000 ft.-lbs., which for a plant developing not more than 15 or 20 H. P., is probably better than could be obtained from any commercial steam plant of equal horse power.

The plant when in operation, will be left to run itself, as it requires practically no care or attention; and no extra labor will be employed to look after it. The successive steps which resulted in arriving at the design of the well itself were described in detail in a paper entitled "Recent Developments in Wells and Pumps," read at the meeting of the American Water Works Association in St. Louis in June, 1904.

A well of this type can be sunk by the pneumatic process through water bearing strata to the depth of 100 ft. The pumping machinery is set in a dry pit, where it is always readily accessible; the pump is set below the normal water level, so that it is always primed at the start, and is within easy suction reach of the bottom of the well; and the capacity of the well in any good water bearing gravel would be very great. The strainer area is so large that, assuming 30% of voids in the gravel surrounding its outer surface, 5,000,000 gallons of water per 24 hours would pass into the well within a linear velocity of only about 24 ins. per minute, which is too small to drag in the finest sand in any stratum worthy of serious consideration as a source of water supply. The metal of the strainer is too thick to rust out, and the perforations are too large to become clogged up.

It is believed that the practical limit to the capacity of the well recently sunk at Peoria will not be determined by the ability of the strainer to admit the necessary quantity of water, but rather by the ability of the water shed to supply this last well in addition to those already in use in the same stratum.

DISCUSSION.

MR. MAURY: Of course, if you have two wells drawing from a water shed of comparatively limited area, you cannot expect a third well to give you as much as if it were the only one. The depth of the water bed has never been definitely determined. I hardly know where our water comes from, or where it gets into the ground. I used to think it came from a long distance up the river, but now think the water shed is not very extensive. Tests and observations there extending over 12 years have demonstrated certain facts. The first is that we do not get any river infiltration. We wish we might, because we feel perfectly certain if we did get the water filtered through a number of hundred feet of gravel before it got to the wells, it would be perfectly safe. The second is that if we are not pumping, the water flows from this gravel stream into the river, so that if we were to stop pumping the water would stand higher in the wells than the water in the river. Some of the proofs that there is no infiltration from the river while at the same time there is a free flow from the gravel into the river are rather interesting. If you have water-beating gravel stratum, with river silt over the top of it, (even assuming there is no solid bed of clay in the bottom of the river, as is the case at Peoria), and the head of water in the gravel is reduced by pumping, and the difference in pressure causes the river water to strive to flow into the gravel stream, you have this condition: the gravel stratum stands there and affords a bed for the layers of silt over the top, and these layers of silt are squeezed down onto that matrix of gravel, until they clog all its pores and make a compact mass which the water practically cannot get through. If, on the other hand, the water in the gravel stratum is higher than the river, the water has free access through the gravel to the bottom of this silt. It then simply lifts up the mass and flows out into the river.

We know that the supply in our gravel stream is largely influenced by the stage of water in the river. We have observed that very often and we explain it in this way. The water in this underground reservoir flows, as I say, from the gravel to the river. If the river is high, the outlets are damned up and water accumulates in that gravel stratum, and the ground water level in it reaches a higher level and we have a tremendously large amount of underground water; so large that our maximum available rate of pumping will only lower it a foot or so. If, on the other hand, the river falls, there is a free outlet afforded for this water in the gravel through the springs that line the river shore, and there is no inlet offered to the river water, so that when you have pumped this basin down to the small end of the cone, you will see that the limit of its capacity is rapidly approached, and we have to keep moving ahead with our wells so as not to reach that limit.

We very rarely use any of these auxiliary or supplementary hydraulic pumping plants. None of them have run more than one-tenth of the time since they have been installed, but when we do need them, we need them badly, because a drought brings with it, as a natural consequence, a largely increased consumption from the water shed. Our experience has shown us its limit, and that it cannot be replenished by infiltration, no matter how low we pull down below the river; so we have got to keep extending the wells.

We made some tests for river infiltration. We sunk a test well out in the river about 1,000 ft. from our main well. On short, say 150 ft. west, was another test well, also 1,000 ft. from the main well. These test wells being equi-distant from the main well, they were equally affected by the draft upon the main well, and the water in each stood at an elevation of 17, Peoria city datum. The water, or rather the surface of the ice (22 ins. thick), in the river was at an elevation of 26; it was the time of the extreme low water in the winter of 1894-1895. When we pumped out the 8-in. test well in the river (the bottom of which went through the clay and into the gravel and was provided throughout its length with a pipe perforated with ¾-in. holes), the water immediately rose to an elevation of 17; the water in the river, of course, remaining at 26. We then reversed the operation and we pumped water into that well and filled it to its top, about 4 ft. above the river, or an elevation of 30; and so there was a head of 30 less 17, or 13 ft. tending to force the water back through the pipe and into the gravel stratum. The experiment was designed to see whether we could get that infiltration. We kept the pipe warm so the water would not freeze, and in two hours the water had not sunk far enough in that pipe to lose the thickness of the capillary film. The water squeezed down the sand and made an absolutely impervious film. We pumped the well out, pumped out the sand, and the water rose to an elevation of 17 in the well before we could begin to get our pump out and measure the depth, it rose so rapidly.

We drove the pipe through the clay and into the same water-bearing gravel which was pierced by the test well on shore. This clay stratum in our territory lies between the bed of the river and the underlying gravel. Fine sand same in but no clay; but that fine sand, assorted by the inflowing water with the fine particles on top made, under pressure, so perfectly tight a dam that an 8-in. pipe did not lose the thickness of a capillary film in two hours.

I cannot say that the water has sunk at all after 10 or 12 years' pumping, because with each yearly replenishment of the underground supply, it comes back as far as it has done before. Of course, as our consumption has increased, we have pulled it down from day to day more rapidly from a high stage, but the water in the gravel itself rises in times of flood just as high now, for equal heights of the river flood, as it used to before. The maximum draft on the first well before we were obliged to go to these auxiliary wells was about 5,500,000 gallons per 24 hours, with a very great increase of suction lift after those 5,000,000 gallons. In fact, the plant that was installed in 1899 in the main well of the pumping station, was installed more to cut out the troubles due to excessive suction lift than to increase the supply; although it resulted in what we think amounts to about 40% increase in that particular well at the time of low water.

We have now the main well, in the bottom of which are sunk four small pneumatic caissons, equipped with strainers on the end. We have the well, a little over half a mile up the river, called the new well, sunk in 1895; and we have the one described in my paper about a quarter of a mile south. Those three are the only wells we have, and as I say, the main well except in times of very severe drought, gives us all the water we want, and we have not had occasion to use either of these auxiliary plants more than a tenth of the time since they have been installed.

Our water supply comes from rather coarse gravel as a rule. The upper well, however, is not in such coarse gravel; that is in sand of medium coarseness, and does not contain much gravel.

The wood stave pipes are absolutely tight when properly made, and the amount of pressure that they can stand is governed entirely by the strength of the bands with which they are surrounded. For a 5 or 10-ft. head it is sufficient to space the bands twelve inches apart. As you get higher and higher pressure, you must increase the number of your bands, move them closer together, and put more of them on; and when you get quite a number of bands on the pipe, say as close as the width of the clamps on your bands will allow you to, you may carry pressures on wood stave pipes up to several hundred pounds. The strength of the pipe depends entirely upon the strength of the bands.

The pipe that has gone through the dipping process was 8-in. steel line pipe. We had available there on the site of an old rolling mill, an abandoned smockstack, and we built a sort of an excrescence on the lower end of that smokestack, which we used as a dipping tank. We had the furnace and we had some old 14-in. cast iron pipe. Of this we made two vertical tanks. The one on the left we kept empty; the one on the right we filled with the coating material. We put up a support for a block and tackle in the smokestack 40 or 50 feet above the dipping tank. To dip a pipe, it was lifted by a hoisting engine and dropped them into the empty 14-in. pipe where it was heated. Then it was hoisted out and dropped into the bath, and another was lowered into the heating pipe. The dipped pipe would then be hoisted out and allowed to drain, and the second pipe lowered into the bath. The coating of some of the pipe has been left out in the weather all last winter and this summer, and the previous summer, and it does not seem to be affected so far. I am not in position to report, of course, how the coating is on the pipe underground. The pipe coating is sold by the American Asphaltum & Rubber Co., and the pipe is known as the mineral rubber coating. It is a comparatively new thing. I believe it is a preparation to a large extent of gilsonite which is a superior quality of asphalt mineral.

MR. NICOLET: Regarding the wooden stave pipe, some ten years ago we had occasion to use about a mile of it; I think it was about 36-ins. diameter, in which the staves were not caught on; simply a plain stave that had a radial face, and in putting the pipe together we had no trouble.

ACCURACY TESTS OF WATER METERS AT DES MOINES, IA.

BY CHAS. B. BURDICK (MEMBER).

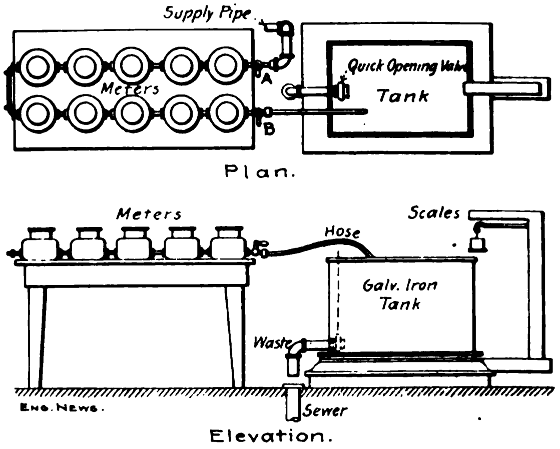
For many years the water meter has been much discussed both in technical literature and elsewhere. In the minds of those well informed upon water works matters there is no doubt as to its practicable accuracy, and it also holds the confidence of the general public wherever it has been given a fair test.

There is no doubt, viewed broadly, that metering is the best and only accurate method of distributing water assessments, and it is no doubt only a question of time until it will be universally used. However, a general introduction of meters must meet with many difficulties. Water rates once fixed are altered with considerable difficulty unless the alteration is downward. If the old flat rate is unfair, under it some consumers are necessarily getting more than value received for their money while others are getting less. Naturally those who are getting an advantage object to a readjustment of rates, and probably in most cases where their water bill has been increased under a rèadjustment they consider themselves unjustly dealt with. In many cases a universal meter system is impossible without a readjustment of rates, particularly where a private corporation supplies the water, as such companies are usually limited by their franchises as to the rates which they charge, and the majority of franchises now existent were framed with little reference to the water meter.

It is customary and necessary in all well regulated water works to make periodic tests of the water meters in service to ascertain whether they are properly registering. It has been the policy of the Des Moines Water Works Co. to test each meter in service once a year. In 1897, however, owing to the rapid growth in the number of water consumers there existed a large number of meters which had not been tested for two or three years. In order to ascertain just what these meters were doing, it was determined to make a general test covering all the meters or so many of them as should be necessary to demonstrate that they were operating satisfactorily. The writer was placed in charge of the testing room in September, 1897, and during the fall and the following winter 1,064 meters of various makes and sizes were removed, tested and replaced, many of them being also repaired. The removing, testing and replacing and much of the repairing was done by the regular employees of the water company at such times as they could be spared from routine work. The regular water works force consisted of 4 men and two one-horse light wagon outfits. Their routine work consisted in setting new meters, reading about 2,500 meters each month, and turning on and shutting off services.

The first meters listed were selected with special reference facility of construction, all those in a certain locality being remove at one time. A summary of the first 400 meters, however, showe such favorable results that it was decided to confine subsequent testi to those meters most liable to be in error, and subsequently mete were selected from the lower levels of the city where it was believ the greater head coupled with the greater shocks caused by numero hydraulic elevators, subjected the meters to greater deterioration tha in the high districts of the city, and also to meters supplying co sumers who used more than 3,000 gallons per month as determin by their bills for February, 1898. The 1,064 meters included pra tically all of that class.

The meters were tested in the workshop and testing room of t water company. The removing and setting of the smaller mete was done ordinarily by one man with a one-horse wagon. At tim there were two or three men gathering the meters working ind pendently. The man would leave the shop in the morning with abo a dozen tested meters in his wagon. Arriving at the house of



Plan.

Elevation.

FIG. 1.

consumer the water was shut off at the cock just ahead of the mete the meter removed and a tested one inserted in its place. The wat was then turned on and the man moved to the next nearest plac returning to the shop at noon and again at night with from 8 to meters. The removal and resetting of from 16 to 25 meters by o man was considered a good day's work.

The meters were usually located in the cellars of the hous supplied. Many of them were set in pits outside. Upon being broug to the testing room the outside of the meter case was brushed clea many of them coming from damp places and being coated with ru and dirt, and immediately placed on the testing bench and teste without examining the interior, the idea being to gain a close idea of what the meter was doing in service.

The testing apparatus consisted of a bench about 2x5 ft., upon which the meters were connected up, and a rectangular galvanized iron tank resting upon a platform scale. The tank was provided with a waste connection controlled by a quick opening valve and an elbow over the mouth of the sewer. The water was measured by weight, using 62½ lbs. as the weight of one cubic foot. Fig. 1 shows a plan and elevation of the testing rig. Brass cocks were placed at A and B, and into cock B was screwed a short piece of rubber hose which led the water from the last meter into the measuring tank. Preliminary to starting a test the smaller meters were usually connected up in series of 8 or 10 as shown in the plan. The lost head limits the number possible to test at one time to about this number.

The method of procedure was as follows: Having the meters connected up as shown, the waste valve of the measuring tank was opened, also cocks A and B, and water enough passed through the meters to free them from air. The waste valve and cock B were then closed, the scales balanced and set and the meters read and recorded. The proper rate disc being placed in cock B the cock was then opened and the water allowed to flow uniformly until the scale beam tipped, when cock B was closed, and the meter again read and recorded. If the meter is in perfect order the difference between the two readings will correspond to the water weighed. Ten cubic feet of water or a multiple thereof was always run, and therefore the percentage registration of the meter could be directly read, with no further calculation than subtracting the first reading from the second.

The first meters were tested under five rates of flow, the rate being controlled by the insertion of a perforated brass disc or washer in the outlet coupling of cock B; the rates of flow corresponding to the various sized discs were as follows:

1/32-in. hole	.035 cu. ft. per minute.
1/16-in. hole	.10 cu. ft. per minute.
1/8 -in. hole	.36 cu. ft. per minute.
1/4 -in. hole	.97 cu. ft. per minute.
1/2 -in. hole (no disc)	1.20 cu. ft. per minute.

After enough meters had been tested to well establish the general form of the regulation curve, we omitted the test with the ⅛ and ¼-in. disc. The meters larger in size than ½-in. were tested singly, using the same sized discs as above. The flows, however, through the larger discs were greater with meters tested singly owing to less lost head.

In testing a set of meters the largest flow was passed first, and if the registration of any meter varied more than 2½% from correct, the meter was opened and examined. It frequently happened that cleaning the intermediate gear restored the meter to good working order. Oftentimes accumulations of various detritus washed from the pipes caused the meter to work hard; the most frequent cause of

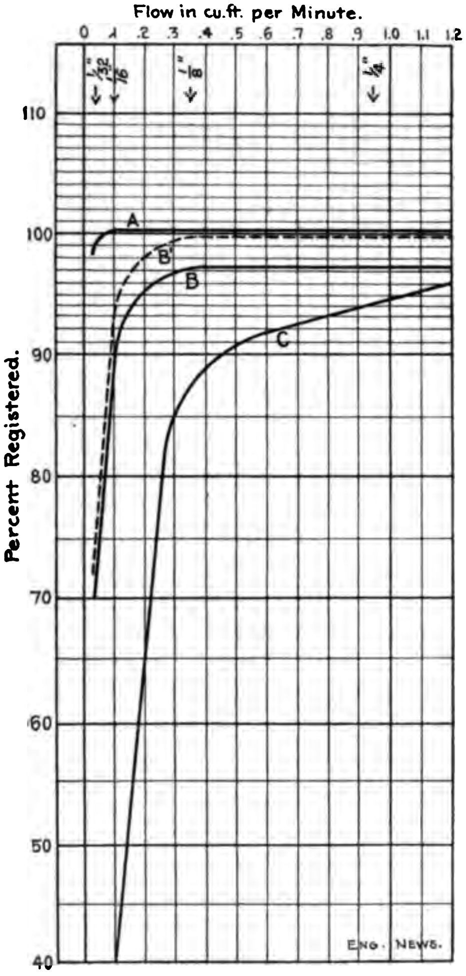


FIG. 2.

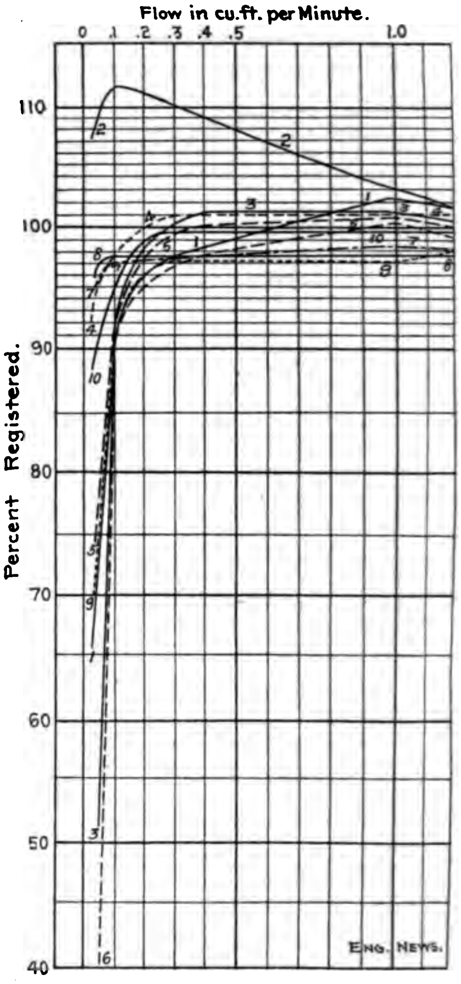


FIG. 3.

Curve No.	METER	No. Meters Tested	Years Service
1	Hersey disk........	32	1 to 4
2	Worthington.......	5	15 to 20
3	Union	14	10 to 14
4	Nash	40	1 to 3
5	Trident	80	½ to 2
6	Hersey piston	197	4 to 10
7	Crown AA..........	88	1 to 3
8	Crown A............	97	3 to 6
9	Crown old style....	372	6 to 15
10	Empire	18	1 to 3
	Total..........	943	½ to 20

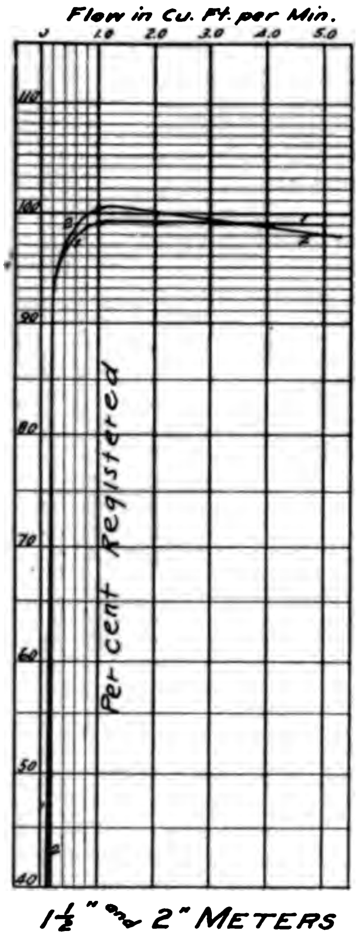
error, however, was wear of the pistons or discs. If a meter required more repairs than a cleaning, the test was run through and the meter set aside for repairs after which it was retested and returned to the service.

The diagram, Fig. 2, is intended to illustrate the effect of wear upon both the piston and the disc type, the Worthington meter possibly excepted. It will be seen that the rate of flow in cubic feet per minute is laid off as an abscissa to the right, and the per cent. of registration is laid off from the bottom of the diagram upward as an ordinate. The upper curve, A, shows a test of a new and perfect meter; the middle curve, B, a meter slightly worn, and the lower curve, C, a meter badly worn. It is seen that wear affects a meter to the greatest degree at the small rates of flow, the registration of the badly worn meter being nearly correct at the maximum rate of flow, but falling off badly at the smaller rates and ceasing to register altogether at the smallest flow.

A defective registration may be corrected in several ways. As before stated often a good cleaning is sufficient. The most frequent cause of error, however, is wear. If the error is small, and the registration holds up fairly well on the small flows, the meter can be corrected by removing one of the wheels from the intermediate or reducing gear and inserting a wheel with one or two more teeth, thereby speeding up the registration gear. This was our practice at Des Moines. A meter that registered over 97.5% of the true flow was not repaired. Meters that registered from 92.5% to 97.5% were speeded up by changing the gear ratio, and meters showing a less registration, particularly if they fell down on the small flows, were sent to the shop. The dotted curve, Fig. 2, shows meter B corrected by changing the gear ratio. It will be seen that this affects the curve by raising it nearly evenly throughout its entire length.

The tabular summary of the tests needs no explanation. Column 3 gives the approximate years in service of the meters tested. This statement is based upon the assumption that each meter was placed in service immediately upon purchase and so remained to the date of test. This assumption is very nearly true as meters were only purchased as needed, and meters were always removed from dead services and used elsewhere. The number stamped upon each meter enables its history to be traced. As to the sixth column marked "O. K. on final test," it should be said that any meter registering within 2.5% (1 gear tooth) of correct was passed as correct. Occasionally we found a meter falling below the 97.5% line which was already geared up to the limit. This was evidenced by the intermediate already containing a wheel with a maximum number of teeth; such meters were always badly worn and deficient at small flows and were also sent to the shop.

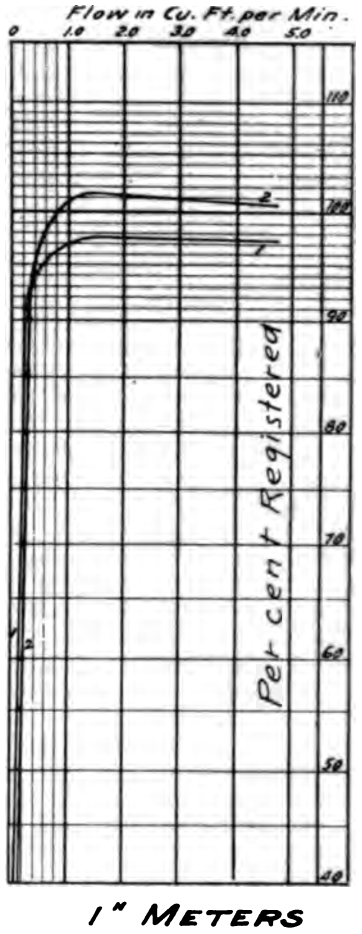
Minor repairs were made in the shop of the water company. Many of the worn pistons and boxes were repaired at a local machine shop and a portion of the meters thus affected were sent to the meter factory. Practically all of the worn meters were of the piston type, none of the disc meters having seen service enough to be seriously worn. Meters of the Crown and Hersey type were most worn upon the surface of the lower plate and upon the lower or rubbing end of the piston. Upon the old style Crowns the lower plate is permanently fastened to the crown or ring surrounding the piston. It is impossible



EXPLANATION

INDEX NUMBER	MAKE	NO. TESTED	YEARS SERVICE
1	Crown 1½"	10	11 to 15
2	Crown 2"	31	11 to 15

FIG. 4.

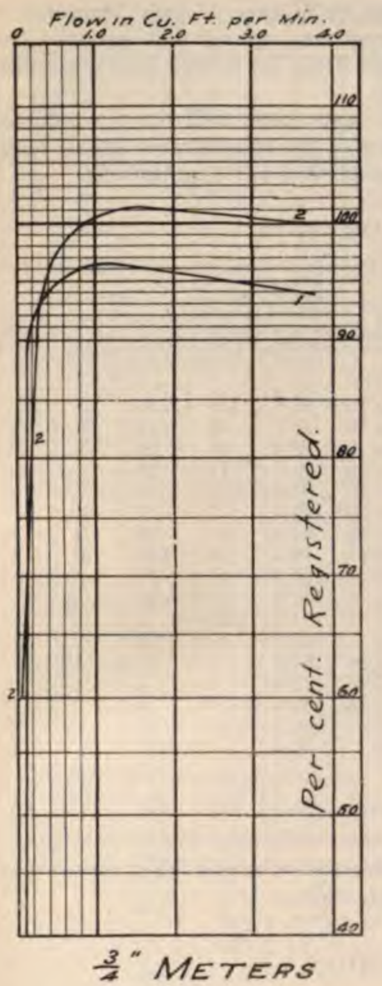


EXPLANATION

INDEX NUMBER	MAKE	NO. TESTED	YEARS SERVICE
1	Crown	21	11 to 15
2	Union	3	7
	Total	24	7 to 15

FIG. 5.

in any ordinary lathe to surface such lower plates; an attempt, however, to repair these meters locally was made; a sheet of tissue paper was laid in the lower plate, the piston set down and wedged in place. The meter was then set in a lathe with the top plate off, and the ring and the top of the piston turned down true and flush. The removal of the tissue paper left just enough play between the piston



EXPLANATION

INDEX NUMBER	MAKE	NO. TESTED	YEARS SERVICE
1	Crown	44	12 to 15
2	Union	11	7 to 14
	Total	55	7 to 15

FIG. 6.

and the plates. This greatly improved the registration of the meter, but if the lower plate was much worn it was always more or less grooved and such a meter could only be made perfect by sending to the factory and having the lower plate faced. The newer meters, having removable bottom plates, were easily repaired by first facing the lower plate, tilting it again in place and turning down the ring and the piston together as above described. The repairs to the disc meters consisted principally in gearing them up and occasionally replacing a defective disc.

Fig. 3 shows graphically the results of the registration tests, the rate of flow being laid off to the right and the per cent. registered vertically as before explained. The meters are grouped first, according to size, and second, according to make. Each curve represents the average of all meters tested of that particular size and kind. Thus the curve marked 5, represents the average result of the 80 ½-in. Trident meters tested. Figs. 4, 5 and 6 give curves for ¾-in., 1-in., and 1½ and 2-in. meters.

It will be noticed that all curves are quite similar. The registration curves of small meters being practically horizontal between flows 0.3 and 1.2 cu. ft. per minute, and from the small flow falling off sharply. The curve of the Worthington meters is, however, different, registering more upon the small flows than upon the large flows. This phenomenon is probably due to a short striking of the pistons under conditions of slow movement. Only five meters of this make were tested and they were almost old enough to vote.

The character of the water at Des Moines is quite favorable to the water meter, being from underground source and entirely free from sediment. The pressure ranges from 50 to 100 lbs., depending upon the elevation of the consumer.

It is considered that the above tests speak well for the accuracy of the water meter, especially in view of the considerable age of many of the meters tested. The results exceeded our expectations.

SUMMARY OF TESTS.

METER	Size	Total Number Tested	Years in Service	Ave. % Registered at Greatest Delivery	Accurate on First Test	REPAIRED		
						*Shop	†E. I. Works	Factory
Crown, old	½"	372	6 to 15	97 8	168	156	8	40
Crown, A	½"	97	3 to 6	98 1	48	47	1	1
Crown, AA	½"	88	1 to 3	98.2	49	36	1	2
Crown	¾"	44	12 to 15	93.7	11	24	......	9
Crown	1"	21	11 to 15	97.6	8	11	......	2
Crown	1½"	10	11 to 15	101 0	7	2	1	0
Crown	2"	31	11 to 15	97 9	11	16	1	3
Hersey, piston	⅝"	197	4 to 10	99.5	70	122	3	2
Hersey, disc	⅝"	32	1 to 4	101.8	15	17	......	.....
Trident	⅝"	80	½ to 2	100 0	60	20	.....	.....
Nash	½"	40	1 to 3	101 0	34	5	......	1
Empire	½"	18	1 to 3	100.1	15	2	.....	1
Worthington	⅝"	5	15 to 20	101 9	5	.....	......	......
Union	⅝"	14	10 to 14	101 6	7	7	......	......
Union	¾"	11	7 to 14	100 0	4	5	.....	2
Union	1"	3	7	100.7	.....	1	.....	2
Union	2"	1	10	96 0	......	......	....	1
Total	......	1064	½ to 20	98 8	512	471	15	66

*This column includes all meters cleaned, geared or repaired in any way by the employees of the water company.

†Machine shop of the Eagle Iron Works, Des Moines.

DISCUSSION.

MR. BURDICK: Fig. 7 illustrates the average result of tests upon ½-in. and ⅝-in. meters. It is a good recommendation for the meter as an accurate water register, particularly as a few of the meters had been in use 20 years, and the average age was probably 10 or 12 years, although many had been repaired, some probably several times. The average meter as we found it in service at Des Moines registered approximately 70% on a 1/32-in. stream; 94% on a 1/16-in. stream, and about 99% on a ⅛-in. stream, and for all the larger flows. The tap hose in the cellar of the water works flowed about 1 cu. ft. per second. That is probably the average flow of any such hose connection. We found, of course, some meters that did not run at all on the low

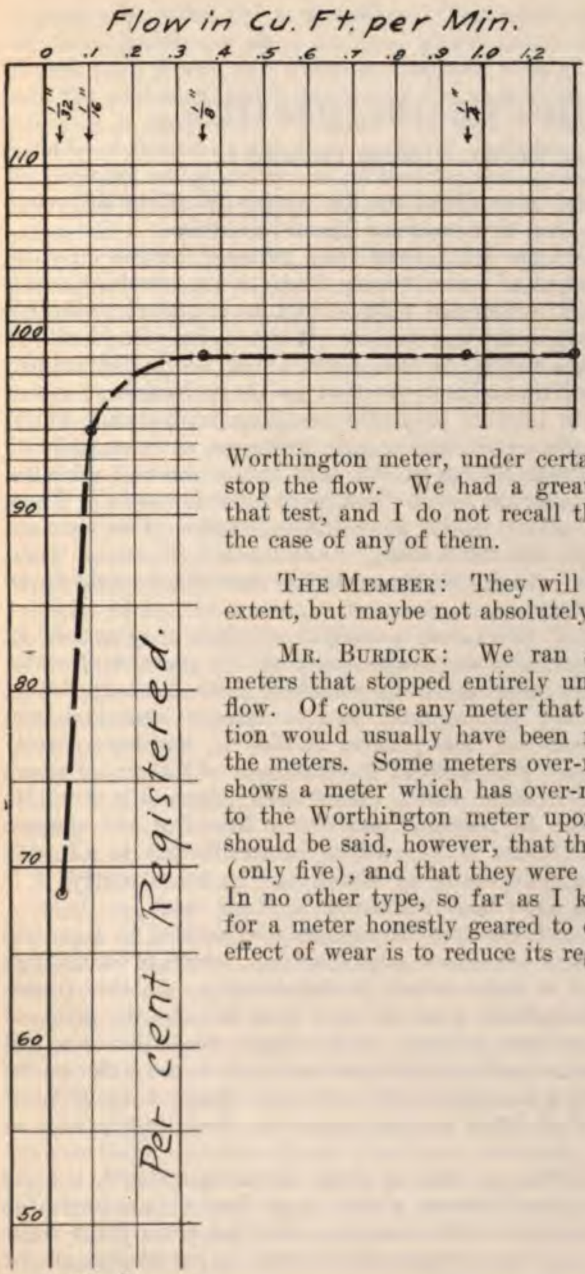


FIG. 7.

streams. Occasionally we ran across one that did not run on a stream of considerable size.

A MEMBER: Some meters are so constructed that they will almost stop the flow. The Crown will do this.

MR. BURDICK: I think the Worthington meter, under certain conditions, will stop the flow. We had a great many Crowns in that test, and I do not recall that it happened in the case of any of them.

THE MEMBER: They will check it to a large extent, but maybe not absolutely stop it.

MR. BURDICK: We ran across a very few meters that stopped entirely under small rates of flow. Of course any meter that was in that condition would usually have been noticed in reading the meters. Some meters over-register, and Fig 3 shows a meter which has over-registered. I refer to the Worthington meter upon small flows. It should be said, however, that these meters are few (only five), and that they were 15 to 20 years old. In no other type, so far as I know, is it possible for a meter honestly geared to over-register. The effect of wear is to reduce its registration.

NOTES ON WATER FILTRATION.

BY DANIEL W. MEAD (MEMBER).

The great advantage gained by the proper filtration of public water supplies has been demonstrated beyond question.

A comparison of the death rates from zymotic diseases in cities having different classes of water supply leads to the conclusion that the properly filtered waters are only second to the pure mountain spring and deep-seated artesian water. While a low death rate is not necessarily due entirely to the character of the water supply, yet the general fact undoubtedly is that as the pollution of water supplies increase, the number of deaths resulting from cerain water-borne diseases also increases; and a pure water, or a water properly purified effects a great saving in life and improvement in health.

I wish to emphasize the words: "Properly filtered waters." There are a great many water works now filtering waters that are not furnishing "properly filtered waters," and, in fact, there are comparatively few filter systems in this country that can be said to be furnishing such waters.

The filtration of water for municipal supplies as practiced in Europe and in America consists essentially of the passage of water through sand, with variation in the detailed method of operation, according to the filter system used, and to various local and constructional circumstances. The general method is, however, usually the same in all cases. The depth of the sand and of the gravel which sometimes underlies it, and which (when used), acts as a drain to the sand bed, varies. In Europe, from two to four feet are common depths, but the minimum is believed to be insufficient to afford a reasonable degree of uniformity in filtration. In this country, it is quite usual to build filter beds with about 4 ft. of sand.

In filtration works, the systems used may be divided in a general way into two classes: 1st. Slow sand filtration, which is common in Europe, and is used to some extent in this country. In this system the water passes through the sand bed at a slow rate, usually at about 2,500,000 gallons per acre per day. 2nd. Rapid sand filtration, and which is also known as mechanical filtration, in which the water passes through the sand at a comparatively rapid rate of about 125,000,000 gallons per day. This latter system is the one most largely used in this country.

Sand is the medium in both of these filtration systems, but the essential agent, or the feature which most largely produces the essential results, is a factor which escaped attention for a great many years, and which was never appreciated until a knowledge of the life and functions of bacteria became general, and the study of filter systems was taken up as a science. The agent to which I refer is the thin, gelatinous sheet or film, which forms over the filter beds of slow sand filters, and which is composed both of the organic matter and the sediment which occurs in the unfiltered water. This film forms as a sheet over the sand with such a fine texture that it is capable of removing the finer material, including a large portion of the bacteria, which are so minute that the sand grains themselves would have practically no effect in removing them. The nature of the natural film is such that it will not permit of a rapid rate of filtration of water. The filtration of water by the slow sand process, to be satisfactory, must be slow and uniform. Any rapid change in the rate of filtration, especially a rapid increase of the rate, will destroy the film and produce poorly filtered and unsatisfactory water. It is undoubtedly true that a considerable organic reduction takes place in the sand bed itself, especially in slow sand filtration, but the film is the principal and important factor.

In order to permit of rapid filtration, a stronger artificial film must be formed, and, for this purpose, a coagulant must be introduced for use in the rapid sand or mechanical filters, in order to form a film of sufficient strength to permit the rapid passage of water. Until within the last two or three years, sulphate of alumina or crude alum has been used almost entirely for this purpose. The sulphate of alumina, when it is in solution and comes in contact with water charged with lime, throws down a flocculent precipitate (a hydrate of alumina) which entangles (as it forms) both the sediment and the bacteria which exist in the unfiltered water. As the water charged with coagulant passes through the sedimentation basin, a large proportion of this coagulant with its entangled impurities is deposited, and the remainder is carried over on to the filter sand, where it forms the film which is the active agent to prevent the passage of suspended impurities through the filter, as long as the filtration occurs at reasonable rates.

Within the last year or two sulphate of iron, or ordinary commercial copperas, has been introduced as a coagulant. In the use of copperas it is found necessary to also introduce lime, as the lime natural to the river waters does not seem to act on the sulphate of iron as it does on the sulphate of alumina.

The cleaning of slow sand filters is accomplished by drawing off the water and removing with thin-bladed shovels about half an inch of the impurities deposited on the sand bed, after which filtration must proceed slowly until the film is again formed. In rapid sand or mechanical filters, it is necessary to wash the filters frequently to remove the impurities which they have previously removed from the water. This washing is done, not by removing the sand, but by agitating it and washing it with a reverse flow of clean water. The wash water carrying the dirt and other impurities in suspension overflows and is conducted to the sewers.

The coagulating basin, in a rapid filter plant, will take out 50 to 75% of the impurities, and a well-designed rapid sand filter, as a whole, will, as a general rule, and under test conditions, remove 98 to 99%. As a matter of fact, in the operation of filter systems in this country, it is quite probable that they do not average, in efficiency of removal, more than from 80 to 90%.

One very important matter to assure success in filtration, is the necessity of good work, and great care in the operation of the filters. Many of our communities that have adopted filtration, seem to think that it is only necessary to construct good filters and good filtration must result; but it is equally, or even more important, to have proper operation. Better work can be done with a poor filter system in the care of an expert, than can be done with a first class filter system in charge of an incompetent man.

In mechanical pressure filters, water is forced from the pumps directly through the sand into the mains, all filtering being done under pressure. As a general proposition, a plant of this kind is not a thoroughly satisfactory one, although it may give fair results. When, however, as is usually the case, especially when such filters are used on direct service, a variation in the demand for water takes place, it becomes frequently necessary, unless a large number of filters are installed, to increase the pumpage above the normal rate of 125,000,000 gallons per acre per day. The result is that the film over the sand is ruptured, and water more or less impure is furnished at such times. If, however, such a filter system is used with a reservoir where the pumpage can be uniform through the filters, the filters will not be open to as great objection. But even in such cases, the main objection to this system of filtration is the fact that the operator cannot see what is going on. He cannot watch the surface, and by lowering the water, find out the state of the sand bed. He must, to ascertain such condition, cut off the pressure, drain out the water, and remove the manhole, and even then he will inspect the filter under great difficulties.

The gravity sand filter plant at Danville was described in the Proceedings for 1904, and a somewhat similar but larger plant has since been constructed for the city of Moline, Ill. While testing one of the new filters, a complaint was made that they were not getting satisfactory results. The settling basins for these filters are designed to give two hours' flow for 5,000,000 gallons of water. If only 2,500,000 gallons were used, the water would, therefore, take four hours to pass through the basins. Sulphate of iron, as a coagulant, settles very rapidly from the water; much more so than sulphate of alumina. At the time of the complaint, they were pumping only about 2,500,000 gallons of water per day through the basin, with both coagulating basins in use. The result was the coagulant all dropped from the water before it came to the filter bed, and no suitable film was formed over the sand. That is to say, about 80 or 85% of the impurities, the sediment and the bacteria, were being taken out in the basins, and the filters were doing little or nothing themselves; thus, the water was passing through the filters in about the condition it came from the basins. One of the basins was cut out so that the filters would receive 15 or 20% of the coagulant to form the film, and the condition of operation was at once improved. So it is evident, that, especially with iron, there can be too long a period of coagulation and sedimentation. This period must be regulated in order to get a proper amount of coagulant on the filter bed. The present practice in mechanical filtration leans very decidedly towards the type of gravity filter, but, as has been previously said, one of the principal requirements for good work with filters is uniformity of work and satisfactory supervision, and until our municipalities realize the necessity of skilled supervision, until they place men in charge of their plants who are competent to examine and to understand the nature of the changes in the condition of water as it occurs from day to day, and the necessary methods of securing proper results under the conditions prevailing, well and properly filtered water cannot be expected. Although there are many filter plants installed in the United States today, there are very few of them that are turning out the character of water which they should turn out. The necessity for skilled supervision, the necessity for careful work, is being realized more and more, and there will soon be an active demand for trained men who are capable of handling the filtration of water in a manner that will guarantee satisfactory results.

REPORT OF THE COMMITTEE ON WATER WORKS.

At the present time 58% of the population of this State has congested in cities of more than 1,000 inhabitants; 97% of this urban population is supplied with water from public works, requiring 206 plants. Basing the consumption upon population, 75% of the water supplied is from surface sources, 13% of which is purified by filtration. The population of Chicago is 35% of the population of the State, and 60% of the urban population. The water supply of Chicago is Lake Michigan, a source of natural purity and a splendid supply when guarded against pollution. This supply, therefore, may be regarded as a special case hardly comparable with the surface supplies of the State generally. Excluding Chicago, 36% of the population is urban, 93% of the urban population is supplied by public works, 38% of the water supplied is from surface sources, 69% of which is purified by filtration. This means that excluding Chicago, 26% of the water supplied in the State is filtered.

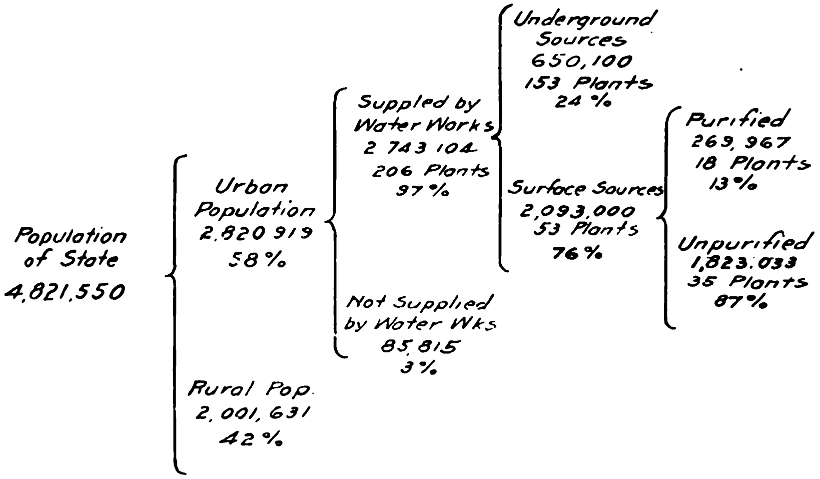
LAKE FOREST. This is one of the earliest filter plants constructed in this State, and consists of six Jewell pressure filters, 6 ft. diameter. The nominal capacity of this plant is 500,000 gallons per day. The average consumption of water by the city is about 400,000 gallons per day, and sometimes reaches a daily pumpage of 750,000 gallons. The source of supply is Lake Michigan, and consequently the very turbid water of inland rivers is not contended with. The water does not receive preliminary sedimentation before passing through the filters. The plant is owned by the Lake Forest Water Co.

ROGERS PARK. The water works are owned and operated by the Rogers Park Water Co., and four American pressure filters, 8 ft. diameter and 8 ft. high, are in use. The distinctive feature of the American filter is the washing system, which consists of hollow castings radiating from a central pipe. When the filter is operating this casting is suspended above the bed. In washing, the finger-like casting is forced into the sand by hydraulic pressure, the same pressure forcing the wash water from the central pipe out through small holes, thereby washing and agitating the bed at the same time. The source of supply is Lake Michigan and no preliminary sedimentation takes place before the water passes through the filters. The plant was constructed in the early '90's.

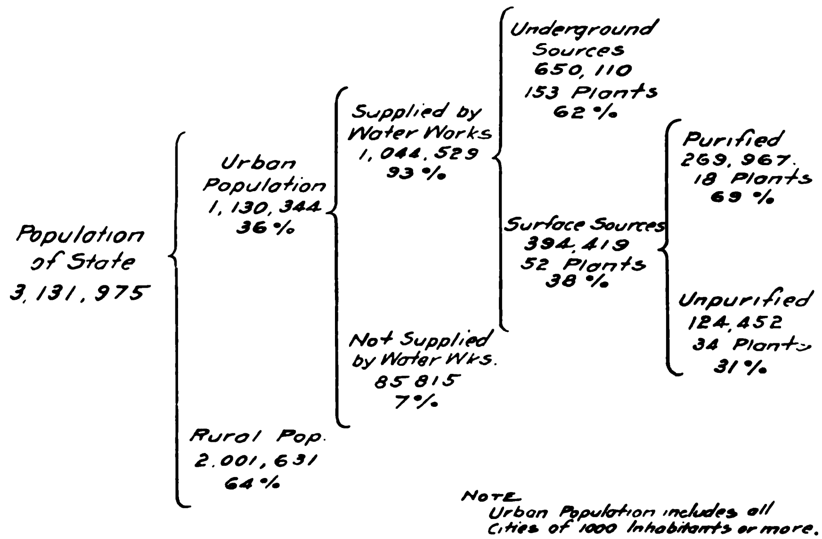
ELGIN. This filter plant was constructed at about the same time as the Rogers Park plant, and as originally built consisted of American filters 10 ft. diameter. The plant has since been added to by the installation of one or more Jewell filters and it is understood that the washing system of a portion of the older filters has been remodeled.

The plant as it exists at present has a capacity of approximately 2,500,000 gallons per day. The filters are of the pressure type and the water receives no preliminary sedimentation. The present source

ILLINOIS, INCLUDING CHICAGO.


Population of State 4,821,550
Urban Population 2,820 919 58 %
Rural Pop. 2,001,631 42 %
Suppled by Water Works 2 743 104 206 Plants 97 %
Not Supplied by Water Wks 85 815 3 %
Underground Sources 650,100 153 Plants 24 %
Surface Sources 2,093,000 53 Plants 76 %
Purified 269,967 18 Plants 13 %
Unpurified 1,823,033 35 Plants 87 %

ILLINOIS, CHICAGO EXCLUDED


Population of State 3,131,975
Urban Population 1,130,344 36 %
Rural Pop. 2,001,631 64 %
Supplied by Water Works 1,044,529 93 %
Not Supplied by Water Wks. 85 815 7 %
Underground Sources 650,110 153 Plants 62 %
Surface Sources 394,419 52 Plants 38 %
Purified 269,967 18 Plants 69 %
Unpurified 124,452 34 Plants 31 %

NOTE.
Urban Population includes all Cities of 1000 Inhabitants or more.

of supply is the Fox river. The city operates the plant and has just made a considerable expenditure for an underground source of supply; when the new plant is in running order, it is presumed that the filter plant will be inoperative.

QUINCY. The water works up to the past year were operated by the Quincy Water Co., but were recently purchased by the city. The source of supply is the Mississippi river, which in flood is very turbid and furnishes a water at such times extremely difficult to purify satisfactorily. The plant, however, has given exceptionally good results since its installation. The water is taken from the river by a set of low lift plunger pumps, passes through a sedimentation basin of about 330,000 gallons capacity, where the coagulant is added, thence passes through 14 Jewell gravity filters 12 ft. diameter, to a clear water reservoir from which the water is elevated into the service reservoir of about 20,000,000 gallons capacity. The filter tanks are of cypress. The coagulant used is ferrous sulphate and lime. It was in this plant that this coagulation process was worked out and the process is commonly known as the Quincy process.

ALTON. The filter plant was installed by the National Filter Co. in 1897. The filters are of the gravity type and the sand is enclosed in wooden tubs. The source of supply is the Mississippi river, from which the water is pumped to an old reservoir which is used as a settling basin. The capacity of the plant as originally installed was about 3,000,000 gallons per day and it is understood that this has since been increased. The plant is owned by the Alton Water Co.

EAST ST. LOUIS. The source of supply is the Mississippi river. The filter plant is somewhat unusual from the fact that the old pressure filter shells, formerly used at New Orleans, are here converted into gravity filters. The plant consists of 17 horizontal shells each 8 ft. diameter and 30 ft. long. The nominal capacity of the plant is 11,000,000 gallons per day. Before passing to the filters the water is lifted to a settling basin by a low-lift plunger compound condensing pumping engine. The settling basin has a capacity of about four hours rest at full capacity of the plant, and is divided into four compartments by wooden partitions. The coagulant is added in this basin. The water passes from the filters to a clear water reservoir of about 1,000,000 gallons capacity and thence passes through the high lift pumps to the city main.

DECATUR. The filter originally consisted of four horizontal pressure filters 8 ft. diameter and 20 ft. long. The plant was installed by the Western Filter Co., and has since been increased by the addition of one or two filters of the same size. The source of supply is the Sangamon river and the water receives no preliminary sedimentation before filtration. The capacity of the plant is 3,000,000 gallons per day.

CAIRO. The filter plant was installed in 1899, the source of supply being the Ohio river, which at flood times is fully as difficult to purify as the Mississippi at Quincy, Alton or East St. Louis. The filter plant consists of six 15-ft. gravity filters of the Continental type. The sand is enclosed in cypress tanks. Before passing to the filters the water is treated by sedimentation in four continuous-flow circular cypress tanks 20 ft. diameter and 20 ft. high, where the coagulant is added. The capacity of the plant is about 3,000,000 gallons per day.

CARLINVILLE. The source of supply of the Carlinville Water Co. is Macoupin creek. The water passes without settling through two pressure filters, one American filter 6x6 ft., and one Jackson filter 8x8 ft. The nominal capacity of the plant is 376,000 gallons per day, and the water consumption of the city averages about 350,000 gallons per day, but is ordinarily pumped in about 20 hours.

MURPHYSBORO. The "Water Works Manual" for 1897 states that one 250,000 gallon Hyatt filter is in use. The consumption of the city largely exceeds this amount. No further information relative to the plant is available.

PONTIAC. The filter plant was installed in 1902 by the New York Continental Jewell Filtration Co., and consists of three gravity filters 15 ft. diameter of the so-called low type. The nominal capacity of the plant is 3,000,000 gallons per day. The source of supply is the Vermillion river, from which the water is lifted by an electrically driven centrifugal pump to two settling tanks 20 ft. diameter and 18 ft. high, where the coagulant (consisting of ferrous sulphate and lime) is added. The filter tubs and the settling tanks are of cypress and are both in one building. The water treated contains large quantities of sediment at time of flood and at low water considerable organic matter giving off some odor. The plant is understood to be giving satisfactory results.

FREEPORT. This plant, unlike any other plant in this State, was installed for the purpose of removing from a deep well water dissolved iron which caused or permitted a vegetable growth known as crenothrix to flourish in the mains. This growth gives the water a very bad appearance and a bad odor. The plant is said to have so reduced the iron in solution that this growth has entirely disappeared. The well water is pumped through two settling tanks 25 ft. 6 ins. diameter, where from two to four grains of lime are added, forming with the iron a precipitate which is removed from the water by four 15-ft. Jewell gravity filters in cypress tanks. The plant has a nominal capacity of 2,000,000 gallons per day.

STREATOR: The plant consists of Western pressure filters, nominal capacity 1,200,000 gallons per day and American filters 1,500,000 gallons per day. The Western filters are of a horizontal type 8 ft. diameter and 20 ft. long. The source of supply is the Vermillion river, and the water consumption is about 1,500,000 gallons per day.

MOLINE. One of the most complete filter plants in the State was completed at Moline in 1903 to handle water from the Mississippi river, which, as has been before stated, is a particularly difficult water to filter. The water is lifted from the river by a centrifugal pump driven either by a steam engine or a water motor as may be desired. The motor is operated by water from the city mains. The raw water passes through two settling basins 50x32 ft., and 18 ft. deep, or about 2 hours' capacity. Thence through these basins by continuous flow to a gravity filter plant consisting of five filter units each 33x10⅔ ft. at sand line. The total of the plant at present is 5,000,000 gallons per day. The settling basins, filters, and clear water resorvoir are built of concrete, and the two former are housed under one roof.

DANVILLE. A good description of this plant is given in the Proceedings of this Society for 1904. The ultimate capacity is to be 6,000,000 gallons per day. The four beds now in use have a capacity of 3,000,000 gallons per day. Two sedimentation tanks are provided, total capacity 250,000 gallons, in which the coagulated water is settled before passing into the filters, giving approximately two hours' rest at 3,000,000 gallons pumpage rate.

ROCK ISLAND. The only slow sand filtration plant in this State was placed in operation in 1900 at Rock Island. The source of supply is the Mississippi river. The plant consists of two settling basins of approximately 3,350,000 gallons combined capacity, giving a period of approximately 24 hours' settlement at the present rate of pumpage. The three filter beds are approximately 145x145 ft. at the sand line, giving a capacity approximately of 3,500,000 gallons per day when worked at the rate of 2,500,000 gallons per acre. The clear water basin is approximately 210x210 ft., and 22 ft. total depth. The basins and filters are lined with concrete and have sloping sides.

KANKAKEE. This plant was installed in 1901. It consists of six rectangular gravity filters at 500,000 gallons daily capacity each, or 3,000,000 gallons total capacity, a sedimentation basin of two hours' capacity continuous flow and a clear water reservoir, all inclosed within one roof. The clear water reservoir occupies the whole lower floor of the building. Upon the second floor is located the sedimentation basin at one end and the filters at the other end. Space is left for installing two additional filters in the future. The filters are rectangular in section and are provided with the air wash which operates through the strainer pipe system and strainer. The filters are hand regulated. The filters and sedimentation basins are supported upon two longitudinal walls running the entire length of the building with arches sprung across the walls and from walls to building foundation. No steel reinforcement is used in the construction.

The low lift plant consists of a Lawrence 8x10 ins. engine belted to an 8-in. centrifugal pump. The works are owned by the Kankakee Water Co., and the plant was installed by the Norwood Company, of Northampton, Mass. The source of supply is the Kankakee river. The present water consumption is from 1,700,000 to 1,900,000 gallons per day.

It will be noticed that with one exception all the filtration plants in the State are of the so-called "mechanical type." This is an

American invention which first made its appearance in 1886, and has since come rapidly to the front. At the present time there are over 140 plants in operation. The pressure type was more popular in the early years, probably for the reason that as then operated, double pumping was not required. This was before the necessity of the preliminary treatment in sedimentation basins was recognized. It required ten years of failure under turbid conditions to prove this necessity. Where provision had once been made to meet this necessity, the gravity type became rapidly popular as it has several advantages not possessed by the pressure type. Since 1900 a number of new filtration plants have been built within the State and all are of the gravity type.

As to the results obtained, the new plants are believed to be doing the better work. This is thought to be due not to anything inherent in the filters themselves, but 1st, to preliminary treatments, and 2nd, to more intelligent understanding of the necessity of careful methods in operation if good results are to be obtained. It is believed that the prevalent custom of purchasing mechanical filters upon a guarantee as to results, and making a thorough series of tests to determine if the guarantee is fulfilled is of very great value to the purchaser, not so much from the fact that such guarantee has any large moral effect in insuring filters of good design and construction, but because in the carrying out of such a test, the local operators are taught to become expert in the management of the filters. They see its best possible results obtained and the method thereof; they see the bad effects of small mistakes and careless handling. The local public also comes to realize these things. The public apathy in these matters is sometimes marvelous, particularly where the works are municipally owned.

It may be said that mechanical filtration has grown up with the germ theory, the general acceptance of the theory occurring at about the same time that the first mechanical filters were built. The application of the germ theory to filter results was, however, not much applied to the early mechanical filters and it was not until 1894, when the tests at Providence, R. I., were published that the bacterial efficiency of the mechanical filter was generally understood. Slow sand filters, which were of earlier origin, were used for many years before their true hygienic value was known. Within the past ten years we have had many public demonstrations of what mechanical filters can do under the most exacting conditions.

The custom has been to base the results of filtration upon the percentage of bacteria removed by the filter, with usually a stipulation that with raw waters of low bacterial life, the bacteria in the filtrate shall not exceed a specified number. A reasonable contract stipulation in this respect is to the effect that at such times as the raw water contains 3,300 or more bacteria per cu. centimeter, the purification effected shall equal 97%, and that with raw water of less bacterial content there shall be in the filtrate not to exceed 100 bacteria. Better results than this can often be obained. There is no doubt but that 100 deadly germs in a filtrate, or even a small fraction of that number would be disastrous to the water consumer. There is good reason, however, to believe as regards disease producing germs the efficiency of the filter greatly exceeds the usual guarantee of percentages.

The case is often cited of Hamburg and Altona, Germany. Both cities derive their supplies from the river Elbe, the water being filtered at Altona and unfiltered at Hamburg. In 1892 a disastrous cholera epidemic broke out in Hamburg, and although its sewage was discharged into the river above Altona, hardly a case of cholera occurred in the latter city. In this case we must admit that the efficiency of the Altona filters must have been very much higher as regards cholera germs than results obtained by our indiscriminate count of water bacteria would indicate.

Such examples as this and other reasons lead to the belief that the present methods of expressing results is somewhat unsatisfactory, and it is believed that in the near future results will be measured by the ability of the filter to remove specific germs placed in the raw water for the purposes of the test.

Dr. Bitter, in his report upon the experimental filter at Alexandria, Egypt, notes that although the raw waters contained a great variety of bacterial life, the filtrate contained only two or three species of harmless water bacteria which he believes had little or no connection with the germs in the raw water, but were germs within the lower sand layers and pipes of the filter. For this reason he based his bacterial test of the filter entirely upon the effect upon a specific germ. The germ selected was the bacillus prodigiosus, and the filter showed quite a remarkable ability to remove this germ; one germ in 1,000 passed the filter directly after washing and the efficiency gradually increased up to 2 hours after washing when only one germ in 20,000 appeared in the filtrate. The report of Dr. Bitter is interesting in many respects, particularly as an opinion from a European point of view, and is decidedly favorable to the mechanical filter.

The present tendency is toward the more permanent constructions. The air wash developed within the past five years has permitted the rectangular form of bed, has permitted an increased size of filter, unit, and both have made easier the use of concrete as an enclosure for the sand instead of wood and steel as formerly.

We are getting some line upon the life of steel shells as time goes on. The present condition of one plant where sulphate of alumina is faithfully used shows that such parts of the filter and pipes as come into contact with coagulated or partially coagulated water at rest are badly pitted after 15 years of use, although the shells are expected to last some years longer.

Sulphate of alumina is still the most largely used coagulant. Ferrous sulphate with lime is coming into prominence and is being introduced into many of the modern plants.

The information as to the various plants described was obtained from published reports, personal notes of members of the committee, and several other members of the Society.

D. H. MAURY, C. B. BURDICK, C. R. HENDERSON.

DISCUSSION.

MR. C. A. PROUT: May I make one correction? Elgin is now using water from its four wells. Well No. 1 is 2,000 ft. deep, and Nos. 2, 3 and 4 are each 1,300 ft. These are connected by tunnels 3.5 ft. diameter, to a central shaft about 9 ft. diameter and 115 ft. deep, where the pumps are located. The water runs by gravity to this central shaft.

MR. BURDICK: In getting together such a considerable amount of information in regard to so large a number of plants, it is quite possible that some of the figures may not be strictly correct, but the endeavor has been to set down in some accessible form what has been attempted and accomplished up to the present time in the State.

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REINFORCED CONCRETE BRIDGE AT KANKAKEE.

BY R. D. GREGG (MEMBER).

The concrete steel bridge over the Kankakee river at Washington Ave., Kankakee, Ill., is 593 ft. long and 46 ft. wide, consisting of seven spans each 73 ft. in length. It has a 5⅓-ft. walk on each side, and a 34-ft. driveway with a street car track in the center. The bridge was designed by the Concrete Steel Engineering Co., of New York, and built by the Marsh Bridge Co., of Des Moines, Iowa. The old iron bridge was of the bow string girder type, with four spans of 125 ft., and two of 50 ft.

The depth of the river at the bridge site during low water is from 3½ to 4 ft., and its velocity about 4½ miles per hour. In laying out the new bridge, two sets of reference points were used, from which a center line and a line at the downstream side of the bridge were established. Two bench marks of different elevations were used, all of which served as checks in alinement and elevations.

The abutments are of rubble concrete resting on a rock foundation; the rubble stones were separated by at least 4 ins. of concrete and not nearer than 10 ins. from the surface. Skewback seats were formed by carrying the abutments up within 2 ft. of, and a distance of 5 ft. horizontally back from the spring line and then sloped up to the top of the abutments, radically with the arch ring. All concrete piers were built up within 2 ft. of the spring line and depressions of about 15x18 ins. made on top at the center and nearly the whole length of the piers. The work was stopped 2 ft. below the spring lines in order to provide for the anchorage of the arched ribs. Forms for the abutments and piers were made of ¾-in. white pine fence flooring, 2x8-in. studding, and 4x6-in. waling strips. They were held in position by ⅝-in. rods passing through the piers and through gas pipes, which extended to within 2 ins. of the surface of the piers. By this means the forms were firmly held in position and the rods very easily removed. For the abutments the forms were braced in the usual manner. Test holes were drilled into each pier and abutment foundation. A temporary foot bridge was erected on the upstream side of the bridge site, the frame bents were made wide enough to carry a car track of a standard gage for the hauling of materials.

A concrete mixer was placed upon a platform about 10 ft. above the street at the north end of the bridge, from which an incline track extended to the street level, and into the rock and sand piles. The mixer was charged by two steel hopper-shaped cars provided with vertical slide doors attached to levers for opening and closing. Each hopper was divided into two compartments with movable partitions, one for measuring sand and the other for crushed stone. The cars were attached to a cable which passed around a drum controlled by a friction clutch. The levers for controlling the mixer and hoisting apparatus were placed so that one man could operate both without changing his position. A second mixer was placed at the south end of the bridge a few feet above the street level and was charged from wheelbarrows. All concrete was mixed by batch mixers and turned from 10 to 15 times. Each batch contained one sack of cement, the sand and crushed stone varied according to the proportions required. Where wheelbarrows were used for charging the mixers they were marked with upholstering tacks to gage the proportions.

The street car track was left on the old bridge, over which a push car was operated by means of a hoisting engine and cable. Under the mixer a platform was erected slightly above the top of the push car. Four two-wheel wheelbarrows, each sufficient to hold one batch of concrete were used in connection with the push car. A wheelbarrow track or platform was placed over each pier at about the spring line, where one wheelbarrow was placed under a vertical spout through which the concrete was dumped from a platform on a level with the push car, then the barrow of concrete was run to any point over the pier as required. This prevented the coarse concrete from separating from the fine. After the abutments and piers were completed the street car track was moved to the temporary foot bridge.

The extreme height from the bed of the river to the street level is 23 ft. This and the narrowing of the waterway 40 ft. necessitated the use of a vertical curve for a grade line and raising of the spring lines in order to provide sufficient waterway. The center of the bridge is 2½ ft. higher than the ends.

The centers for each arch consisted of six frame bents properly sway braced and braced longitudually. The joists were Oregon fir cut out of inch planks, 3x12 ins., and supported by double wedges, resting on the bent caps. The lagging was of 2x8-in. hard pine, surfaced one side, and all depressions filled with potters' clay. The ends of the joists at the spring line were supported by the studding of the pier and abutment forms. The centering was unyielding, and no difficulty was experienced in striking it. The crown of the centers were raised 1/800 of the span above the intended height of the finished arch, to allow for settling when the centers were struck.

The steel re-enforcement of the arch rings consisted of 1⅛-in. Thacher bars in pairs one above the other and extending well into the abutments and piers; the bars of each pair were connected by vertical ½-in. round rods with a hook at each end, which were closed with a hammer during the erection of the metal work; they were placed at intervals of 4 ft. The main bars of each arched rib are coupled by four turnbuckles. The ends of the bars that extended into the abutments and piers are provided with nuts and O. G. cast washers 4 ins. diameter. The arched ribs are 17 ins. center to center, and the lower bars of ribs are 3 ins. above the lagging. The adjustment of the ribs was easily made by the turnbuckles during the turning of the arch. The thickness of arch rings at the crown is 16.1 ins., and at the spring line 32.6 ins. Radii of intrados of arch, 21.78 ft. and 97.82 ft; radius of extrados, 107.7 ft. Six sets of ¾-in. transverse Thacher bars were placed in each arch and tied to the arch ribs with small wire. The ribs were kept at the proper distance from the lagging by the use of wedge-shaped blocks, which were moved ahead as the turning of the arch progressed.

Medium steel of an ultimate strength of 60,000 to 68,000 lbs. per sq. in. was specified for the arched ribs, which had a sectional area equal to 1/150 part of the total sectional area of the arch ring at the crown. In building the skewbacks the concrete was dumped upon a platform and then shoveled into place, this enabled the workmen to keep the concrete thoroughly mixed and proved to be the best manner in which to place it in the skewback among the rods. In turning the arches, a one-third longitudinal section of the arch ring was taken as one day's work. The placing of the concrete was started simultaneously at each skewback and carried forward uninterruptedly until the section was completed. Extraordinary care was taken in placing concrete under the arched ribs. Shovelsfull of fine concrete selected from the batches were dropped 3 or 4 ft. and in narrow strips without scattering, and the coarse stone pulled upon top with a shovel. This operation continued sufficiently to keep ahead of the ablance of the work. Shovel tamping was done under the ribs and especially at the connecting rods; by this means dense concrete was made at a difficult and vital part of the arch ring. Anchor plates for the spandrel wall forms were set at intervals during the work on the arch. The top of the arch was floated with the back of a shovel blade. With a little extra care a workman can put on a very good finish. This finish was followed with a coating of cement and fine sand, 1 to 1, slushed on and brushed in until a uniformly smooth surface was made. An extra heavy coating was put on the joints between the longitudinal sections of the arch rings. All completed work was sprinkled from 2 to 4 times a day for two weeks.

The expansion joints in the spandrel wall over the spring lines are hidden by the pilasters. The walls were built in alternate sections, and potters' clay was used at all expansion joints instead of paper. A shoulder, 4x4-ins., was placed in the edge of the coping for a seat for one edge of the sidewalk; this will obviate an objectionable appearance of the walk should the filling settle. The railing was built of paneled slabs re-enforced with steel bars. It became necessary to place the trolley poles in the curb line instead of in the railing on account of the discoloration of the bridge by rust, splitting of railing posts by vibration, and obstructing the view from the sidewalk. Cast iron sockets for the poles extended from the skewbacks up to the bottom of the curb; they were set in concrete and were made considerably larger than the poles for the purpose of plumbing the latter.

The spandrel filling was composed of clay, gravel and broken stone. Instead of tamping the filling, it was flooded for two days with a 2½-in. hose attached to a city hydrant. The inlets of the 4-in. drain pipes over the piers at the skewbacks were covered with coarse stone, then a layer of crushed stone, and a layer of gravel. Wire screens were not used. There was no seepage whatever through the arch rings, during and after the flooding of the fill.

Portland cement of the Chicago A-A brand was used throughout the entire work. A Fairbanks cement testing machine of 2,000 lbs. capacity was used, also the Gilmore needles. The fineness required was 75% through a 200 mesh sieve of No. 45 wire, Stubbs gage. Briquettes made from the residue of cement retained upon a 200 mesh sieve, showed comparatively no strength after one day in the damp chamber and six days in water. Out of 4,000 barrels of cement standing the above test for fineness, there would be 1,000 barrels of residue, equal in value to 1,000 barrels of ordinarily fine sand. This would seem to indicate the great importance of finely ground cement. Briquettes of 1 part cement and 3 parts stone screenings through a 20-mesh sieve and caught on a 30-mesh sieve, greatly exceed the requirements of the specifications, which were 170 lbs. for 7 days and 240 lbs. for 28 days. Apparatus for the boiling test consisted of a 5-gallon pail with a cover, and a wire basket suspended inside. Gas was used for boiling the water and the temperature very easily regulated. The pats were placed in cool water which was brought to the boiling point in about one hour. Stone screenings were exclusively used, and the stone dust was not sifted out. Briquettes of 1 part cement and 3 parts screenings through a 30-mesh sieve showed a strength of 370 lbs. to 400 lbs. after one day in damp chamber and 27 days in water.

The grades of concrete used were as follows: For piers and abutments, 1 part cement, 3½ parts stone screenings, and 7 parts broken stone that will pass through a 3-in. ring. For spandrel walls, 1 cement, 3 stone screenings and 6 broken stone that will pass through a 2-in. ring. For arch rings, 1 cement, 2 stone screenings and 4 broken stone that will pass through a 1½-in. ring. For the railing, 1 cement and 3 stone screenings. Where stone screenings are used it is necessary to make the concrete quite wet and to thoroughly tamp it in order to make the concrete dense.

Conduits for the telephone and electric light wires were placed under the sidewalks, also a gas main was placed under the walk. The bridge was calculated to carry a live load of 125 lbs. per sq. ft.; concentrated load, a 17-ton steam road roller with 11-ft. wheel base.

The center of two spans were struck twenty-two days after the arch rings were completed. The settlement at the crown of the arches varied from ⅝ to ⅞ in. A 17-ton road roller was run over the bridge 46 days after the last arch ring was completed. Work was commenced April 15 and the bridge was completed October 15, 1904.

HIGHWAY BRIDGES IN ILLINOIS OUTSIDE THE CITIES.

BY FRANK W. IVES (MEMBER).

The earlier bridges built in Illinois were of course built of native wood, then the only available material. As early as 1832 the covered wooden bridges came into service for long spans. With the construction of the national road came the most durable of the structures, and one of the oldest bridges of any description in Illinois, is one of these which still remains in service in Clark County on the old national road. These bridges were costly even in those days when timber was plentiful, but so well built that there are now about 30 still in service, constructed mostly between 1843 and 1882. The last one of these covered bridges to be built was on the ferry road opposite Keokuk. Another style of early wooden bridge was that built on piles in bents of 16 to 20 ft. for shallow or sluggish streams; these were in many cases several hundred feet longer than a modern bridge would be built.

Following these wooden structures in 1858 came the old iron bowstring arches. It was with much difficulty that early contractors induced country officials to see any merit or value in iron bridges; their cost was almost prohibitive, and officials were timid about trusting to them. The first was in Galena about 1858. Along with the iron arch bridges came also the combination bridges, and for some years bridge contractors had a good business re-wooding these combination structures. But they have gone their way, and with the iron arches they are now practically obsolete.

Following came the iron and steel trusses of various designs, but the first ones always with wooden joists. With the advent of the steel I-beam and its utiliy as a floor joist, came more lucrative business for contractors in replacing the old wooden joist with steel, but this business is rapidly passing, and wooden joists on steel bridges are now rarely asked for. The rapid falling off in quality and quantity of oak lumber has brought up the problem of what to do for bridge floors.

This brings me to the bridge of today or of the past two years. About 95% of these structures are I-beam girder bridges for spans up to 30 ft., and either pin-connected or riveted low trusses for spans from 30 to 75 ft. Spans above 75 ft. are almost invariably pin-connected high trusses, all with steel joists, steel railing and plank floor.

With the evolution of the steel bridge and its improvements there has not been a noticeable increase in the amount of metal used in the construction of the trusses. Many of the early arch bridges were quite heavy in their top chords or arches, even though they were light in other places, but as the style changed and Pratt trusses came into favor, the top chords were lightened very materially, so that the weight of the average Pratt truss was less than that of an arch of corresponding dimensions. In fact in the past 15 years many bridges have been built which were strained down almost to their last limit of safety by ambitious contractors in order to bring the cost within the means of the purchaser. This practice is indulged in to a great extent even today and is the most serious competition which responsible contractors have to meet in bidding for public works.

From time long past the specifications for capacity of country bridges and culverts has been "one traction engine," and when one stops to think that this may mean a load of 12 tons on 10 ft. centers of bearings, it is no small requirement; in addition to calling for more substantial trusses and girders it makes necessary a more substantial floor. Pine flooring is easily broken by the big wheels of the engine and oak is hard to secure, is more expensive than at any previous period, and is generally of a lower grade than formerly. So to meet this condition the more progressive localities are beginning to build bridges with permanent floors. The style most favored now is re-inforced concrete or concrete laid on buckle plates or expanded metal. An economical plan for such a floor was used at Mansfield, Ill., in 1904, on an I-beam span, 30 ft. long, with a 16-ft. roadway. The floor consisted of concrete 6 ins. thick at center, sloping to 5 ins. thick at each side. At 1 in. from the bottom and imbedded in the concrete, laid transversely 6 ins. apart, were ½-in. corrugated iron bars, and 1 in. below the top surface were the same kind of bars, spaced 12 ins. apart, making three bars to each lineal foot of floor. The top of the floor was given a 1-in wearing surface of concrete composed of equal parts of Portland cement and crushed stone screenings. This bridge was supported by concrete abutments, into which the ends of the girders were set. Thus any other permanent floor may be placed on truss bridges of any length, though the steel structure will need to be much heavier to carry the increased dead load.

Perhaps 80% of the culverts in Illinois are wood. The other 20% are of stone, brick, vitrified tile, steel cylinders, cast iron pipe, old boilers, flues and smokestacks.

The wooden culverts vary in style according to size and location. Many small ones are simply three 2-in. planks, 12 ins. wide, two set upright 8 ins. apart, and the third laid over them to form the cover. This form is used in the level sections of the State to carry the water across the roadways in times of rain, but are not for constantly running water. Another common style consists of posts 4x4 ins., 3 or 4 ft. long, set in the ground far enough apart to leave a waterway of about 2½ or 3 ft. Backing planks are nailed to these to form the sides of the culvert and the top is covered with three plank, the center one laying flat and the one on each side laying on an incline to facilitate the crossing of travel. The plank are supported by stringers 4x4 ins. resting on top of the posts, and beveled to allow for the incline of the plank.

There are many wooden culverts built as wide as 10 and 12 ft., and 10 ft. high in places where the waterway is deep. These are constructed of oak piles capped with 6x6-in. timber and supporting 3x12-in. joist and floor. The cheapness of this method of building culverts makes them very popular, though they are a constant care as well as a menace to the public. The water nearly always finds some way to wash out the filling behind them and frequently leaves large gaps and holes where horses are likely to be caught. Then the thin flooring generally used is easily broken by engines and other heavy traffic, so that about 50% of the wooden culverts are always in need of repair.

The drain on the township treasuries to meet the cost of these repairs, although of minor importance in each case, amounts to so much in total in many vicinities, that no funds can accumulate with which to build permanent culverts, and it has seemed a difficult task in many places to get enough ahead to make any permanent improvement.

But the wooden culverts are not the only transient ones. Some are built of short sections of vitrified tile laid in a ditch and covered with earth. They rest well until the first heavy rain or the first frost. The road official undertook to secure this unruly culvert pipe by building a wall of brick or stone or sometimes even a plank at each end, but the frost would not press alike on all sides at once, and would push the center joists up from the bottom or bulge them out from one side or the other, so that the first heavy water rush would find its course impeded and proceed to spoil things. Some officials have secured the pipe by imbedding it in concrete, thus making it a lining for a concrete culvert and others have built a wooden crate or framework the entire length of the culvert, which has in many cases secured the pipe from washouts, but even then there is the danger of wheels in muddy times going down and striking the pipe and crushing it.

Another make-shift is the use of old boilers, boiler flues and worn out smokestacks, which are being utilized in some places, particularly in Peoria, Knox and Fulton counties, on account of their cheapness. They will soon rust, or flatten, or crush, but usually give satisfactory service while they last. Stone and brick have not proved entirely satisfactory for culverts for the reason that they are not always placed on a secure foundation or are not stiff enough to hold the pressure of dirt, so that the keystone or crown of arch frequently falls in, wrecking the structure. While they are more durable than the styles mentioned before, they are not permanent as usually built, and are not now being built to any great extent in Illinois. If constructed of hard burned brick they will do well provided the mortar can be made to adhere permanently to the brick.

Another make-shift which is being used extensively is the steel cylinder, usually made of 3/16 or ¼-in. metal, and in from 18 ins. to 7 ft. diameter. If these were made of very much heavier material they would make a good lasting culvert, but the larger ones require much stiffening, which is provided by riveting angles around the outside of the tube, and they rust through in a few years. These steel culverts are often laid across the roadway and made long enough to extend beyond the limits of the driveway and having no provision at either end for holding the grade. Frequently they are provided with steel ends consisting of thin steel plates sometimes 5 ft. sq., but varying in accordance with the diameter of the tube, and the requirements of the situation. Another method, and perhaps the best one, is to build a stone or concrete headwall at each end, large enough to hold back a sudden rush of water and to prevent its undermining the culvert.

Cast iron pipe is the best manufactured article for making durable culverts. On account of its rust resisting properties and its greater weight and thickness, it behaves much better than steel. When placed on masonry foundations and with headwalls of concrete they are perhaps as nearly permanent as a metal culvert can be built. In the long run they are the most economical culverts, especially in deep cuts or ravines between steep hills where a deep fill is necessary. The United States government built six culverts of this kind under the roadway leading to the National Cemetery, at Mound City, Ill., late in 1903. They were from 24 to 84 ft. long each, and cast iron pipe 36 ins. diameter, weighing 350 lbs. per ft. was used. There were six or more sections of pipe to each long culvert, each section fitting into the socket or bell of the next section. These joints were caulked with oakum and lead. The average depth which these pipes were placed below the top of roadway was 15 ft., and four of them were placed by digging a square tunnel 6x6 ft. through the high embankment. At each end was built a substantial concrete wall. This work was done under specifications furnished by the U. S. army engineers and under their supervision.

There are many modes of building concrete and stone culverts. Several new plans built during the past two years have been in the nature of experiments. For small stone culverts, one township is building of 4-in. slabs of Joliet stone, set up edgewise on each side of the waterway, and a similar stone laid across the top for a cover. These stone are usually 4 ft. square, and four placed end to end form a 16-ft. culvert. There is danger of water getting behind the stone sides and washing out the fill. A better stone culvert has two 12-in. masonry walls supporting a 12-in. cover stone to make a culvert 4 or 6 ft. wide. This same style is used for much wider waterways and the cover stone supported by old rails. In this case the cover stones are usually made 3 ft. wide and long enough to extend across the opening, and far enough on to each wall to have a firm bearing. Under each stone are placed two rails.

The concrete culvert is likely to become the most popular in some of its forms. It is easily adapted to all sorts of conditions and localities. In nearly all parts of the State can be found suitable concrete material, and this fact eliminates quite a large item for transportation, which enters largely into the cost of stone structures. There is, (1), the concrete arch without steel re-inforcement; (2), the same for longer spans with steel re-inforcement; (3), the radial block arch culvert made with concrete foundations and wings and on top of the foundation the arch formed of hollow concrete building blocks, so made as to lay in a semi-circle. These are useful in culverts up to 6 or more feet, but their value consists largely in the quality of the blocks that enter into its construction. Until blocks are made that are absolutely reliable this culvert will be under suspicion. The same kind of a culvert is being built, using hollow vitrified blocks instead of concrete blocks, laid in cement mortar. There seems to be some possibility that in both these blocks there is some danger of moisture getting into the hollow parts in sufficient quantities to freeze and break the blocks and make trouble. However, no such thing has occurred in culverts of this kind that have come under my observation.

A more satisfactory culvert than any other is the flat top re-inforced concrete culvert. In this we almost lose the distinction between a culvert and a bridge, as the same design and plan may be carried out whether the waterway be 2 ft. or 36 ft. wide. The design is simple, consisting of two concrete abutments and four wings, varying in thickness according to the height of same and length of the span. The wings should be built up higher than the abutments, to the level of the floor anyway. On top of the abutments are placed I-beams spaced 2 to 3 ft. apart (depending on weight of beam) and on top of this is the re-inforced concrete floor. The I-beam joist should be imbedded in the concrete abutment so that the lower side of the floor is at the same level as the top of the abutment, in order that they may be absolutely incorporated with each other. The same plan may be and has been used for short culverts by using old rails instead of I-beams and omitting the corrugated bar re-inforcement, but imbedding the rails entirely in the concrete floor, thus protecting them from rust.

The concrete should be made (where possible) of crushed stone and crushed stone screenings, washed gravel and torpedo sand. Common bank or river gravel and sand is used extensively also, but care must be taken in such cases to keep out clay and vegetable matters.

There should be some official basis of calculation or some prescribed form of general specifications to guide the country officials in their selection of bridge and culvert plans. There should be a State Engineer or Bridge Commissioner whose duty it shall be to supervise all bridge and culvert construction. As it has been the prevailing sentiment that the lowest bid on bridge and culvert work must be accepted by officials, and as ignorant and incompetent contractors recklessly "skin" their plans in order to be lowest bidders, it seems that such an engineer or commissioner, whose duty it would be to pass upon and approve all plans for bridges contracted to be built, could do much to improve affairs. He would also be a protection to the better class of contractors and bridge shops who desire to improve the quality of their work, but who are forced to meet the competition of an irresponsible class of bidders.

REINFORCED CONCRETE STRUCTURES.

BY T. L. CONDRON (MEMBER).

Interesting illustrations of the application of reinforced concrete to structures are found in the designs of ordinary highway culverts or bridges of short spans. In Marion County, Indiana, approximately 100 concrete culverts reinforced with corrugated bars have been built during the past two years. The illustration shows a typical design for these culverts. To give an idea of their cost, the following contract prices have been given to the writer by Mr. H. W. Klausmann, County Surveyor, who designed and built them.

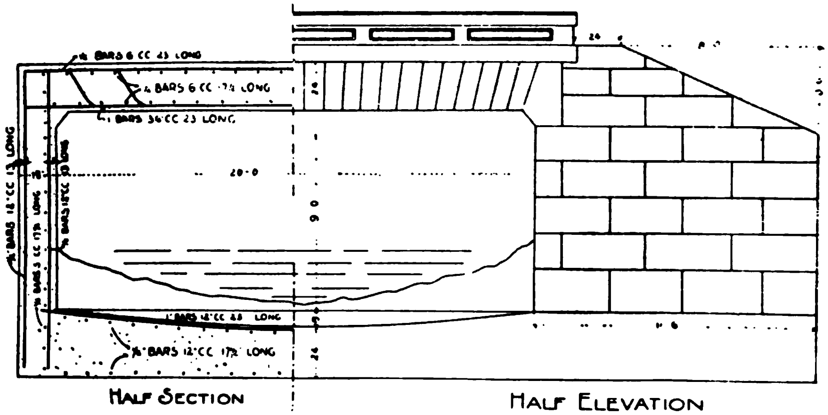
Clear Span ft.	Total Length ft.	Clear Height		Roadway Width ft.	Cost Total
		ft.	ins.		
10	26	6	9	16	$ 870
15	31	7	0	18	967
15*	30	7	3	18	1.145
20	40	9	9	16	1.163
40†	62	9	6	16	2.410

*Skew.
†Two 27 ft. spans with 2 ft. dividing wall.

In this same county a retaining wall 16 ft. high and 300 ft. long, without an expansion joint, was built last fall and at this time (April 8) a careful examination shows that there is not even a hair crack in the entire surface. This wall was reinforced as a cantilever beam fixed at the base; also a sufficient number of bars were placed longitudinally to take care of temperature and shrinkage stresses. The reinforcing for this purpose was 1-300 of the cross section of the wall, or one-third of 1%. This wall also stands without tipping out, while nearly all of the monolithic retaining walls built in connection with the Chicago track elevation work have tipped out from 4 ins. to 2 ft. at the top; also, although expansion joints are made every 50 ft., shrinkage cracks appear in these monolithic walls between joints.

In the case of reinforced concrete bridge abutments as built by the Wabash Ry., a very marked saving was made over the cost of monolithic abutments. The former have greater stability due to their shape, and also are free from unsightly cracks.

The application of reinforced concrete to bridge floors, both for highway and railway bridges, is leading to an entire change of practice in this important field. For highway bridges not only can reinforced concrete floors be put in more cheaply than buckle-plate floors, but they are lighter and hence reduce the cost of the girders or trusses. For light highway bridges those floors cost but little more than a wooden floor, and require no maintenance expense. For railway bridges several roads have already made such floors standard. The most satisfactory bridge floors on the Chicago track elevation are of this type. They have proved to be waterproof and cost less than the creosoted timber and ballast floors previously been put in on the same work.



REINFORCED CONCRETE CULVERT, MARION COUNTY, INDIANA.

To illustrate the strength of this construction several panels of the warehouse floors of the new 16-story building of the North American Cold Storage Co., at Chicago, were tested recently with a load of 1,200 lbs. per sq. ft., or a total of 270,000 lbs. (six car loads of pig iron), on an area 15 in. by 15 ft. These floors are slabs 8 ins. deep, with ½-in. corrugated bars spaced 3-in. centers, designed for 300 lbs. per sq. ft. load, and the deflection under this severe loading was ¼-in. at the center.

Another interesting example of this kind of construction is the circular tank at Lake Geneva, Wis., 50 ft. in diameter and 17 ft. high, the wall of which is from 4 to 8 ins. thick. This reservoir is water tight and otherwise satisfactory.

In conclusion the writer gives his formulas for proportioning steel concrete beams; a full analysis of these will be found in the Journal of the Western Society of Engineers for April, 1905.

$$M_R=\frac{Sbd^2}{120}\left(P+\tfrac{1}{10}\right)\ (1);\qquad d=\sqrt{\frac{120M_R}{Sb}\left(P+\tfrac{1}{10}\right)}\ (3);$$

$$P=\frac{120M_R}{Sbd^2}-\tfrac{1}{10}\ (2);\qquad \text{and } a=\frac{1.2\,M_R}{Sd}\ (4)$$

M_R=Moment of resistance of beam in inch-lbs.
S=Tension in the bars per sq. in.
b=Breadth of the beam in inches.
d=Depth of beam to the plane of the bars in inches.
a=Area of reinforcing bars in the beam.
P=Percentage of reinforcing $=\frac{100a}{bd}$

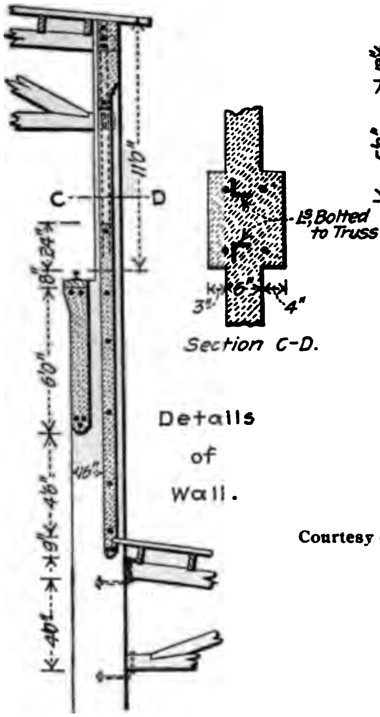
For average rock concrete and plain steel bars of 33,000 lbs. elastic limit, S=8,200 will give a factor of safety 4; while for corrugated steel bars of 55,000 lbs. elastic limit, S=13,800 will also give a factor of safety of 4. That is, it requires 60% more area of the former than of the latter for equal strength of beams. It should be borne in mind that for S=elastic limit of the steel, M_R=Ultimate moment of resistance and therefore S can never be greater than the elastic limit of the bars. It is erroneous to consider that if the stress in the steel is but ⅛ of the ultimate strength, there will be a factor of safety of 8 in the steel concrete beam, but rather, if the stress in the steel is ⅛ of the ultimate strength of the steel, the factor of safety will be about —4, for the elastic limit is between 50 and 60 per cent. of the ultimate strength.

REINFORCED CONCRETE BUILDING.

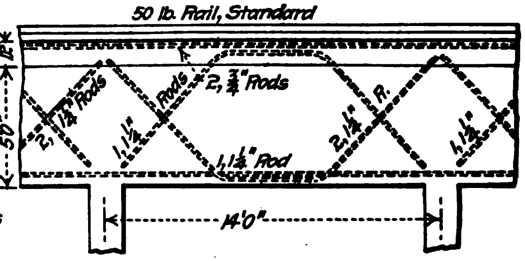
BY C. C. STOWELL (MEMBER).

Two interesting examples of this construction were executed during 1903. The first is a building for a machinery erecting shop. The plans were drawn for a structure of brick and wood, and the re-inforced construction was afterwards adapted to these plans. The building is 200x60 ft.; 44 ft. of the width is used for erecting purposes, and 16 ft. for a bench shed, where all fitting is done. The 20-ton traveling crane weighs about 21 tons. To distribute the vibrations and shock due to the movement of the crane when handling its load, the roof trusses were made deeper than otherwise necessary, and fastened to angle irons which extended down in each part about 2 ft. below the upper windows. Horizontal rods were passed through the angles, above and below the windows, and made continuous by means of long sleeve nuts, throughout the length of the concrete walls, thus tieing the whole structure together.

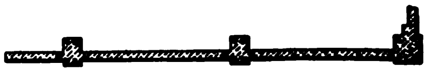
The second structure is that of a foundation for a water softening plant for a woolen factory. The interesting points of this structure are: the load carried, the difficulties presented by its peculiar location, and the unusual design. The coloring tanks were an after-thought



Details of Wall.



Part Elevation of Runway Girder.



Part Horizontal Section of Outside Wall.

Courtesy of "Engineering News.")

and are carried on the building wall and piers by cutting niches each about 6 ins. deep for supports for the bottom of each girder which carries the upper floor, the bottom of the tanks and also serve as partitions between the tanks. The liquid coloring matter goes into the tanks boiling hot. The girders or partitions in the left three tanks carry a concrete trestle which supports one end of the concrete floor on which rests the filtering tank.

NOTE—The erecting shop was designed by Mr. W. W. Crehore for the Ingersoll Machine Co.

BRIDGES OF THE QUEEN POST TRUSS TYPE.

BY F. G. FRINK (MEMBER).

The question of stresses in the ordinary queen post or trapezoidal truss is one that come up with such frequency as to indicate much uncertainty in regard to them. An inspection of highway bridges of this useful type shows that the uncertainty has frequently resulted in curious and extravagant construction through the efforts of the builders to make sure that their work should at least hold together. Nor is this doubt confined to those who, claiming no skill except in the use of tools, candidly resort to copying or "main strength and awkardness."

Being convinced that this truss is really an excellent one for small bridges an attempt will be made to show that the stresses are entirely determinate and obtainable by simple methods, and that with reasonable attention to details, this bridge is well calculated for use on highways, even under the heavy concentrated loads to which modern use may subject it.

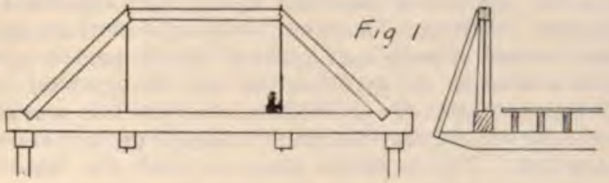


Fig 1

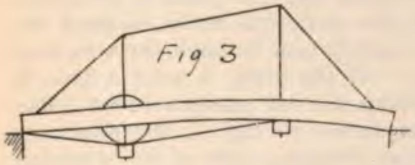


Fig 3

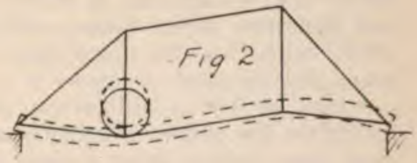


Fig 2

As it has become familiar to all of us, the truss is commonly built of timber with vertical iron rods and with no central bracing, as shown in Fig. 1. The principles under which the stresses are developed are briefly as follows: Under the action of a uniform or symmetrical load the stresses are exactly as in an ordinary truss, no central brace being called for. The upper chord and batter posts are in compression and the lower chord and vertical rods are in tension with no bending stresses anywhere. With the introduction of a concentrated load, however, which may be represented by placing a heavy wheel opposite one of the rods, there arises a tendency to distortion and the frame, if pin jointed, would assume some such shape as shown in Fig. 2, owing to shear in the middle panel. This inclination is prevented by using for the lower member a timber that is stiff enough to keep the lower joints in line.

In order to design this "straining beam," as we may call it, we notice that the unloaded joint will rise with the same force as that with which the loaded one falls, the action being similar to that of a pair of balances. As regards the action on the straining beam, we may then consider that half of the unbalanced weight is resisted at the point beneath it and the remaining half at the other vertical where it acts as a pull upward. The beam is then under forces which tend to force it into the form shown by the dotted lines in Fig. 2. We note that a point of reversed curvature or contraflexure occurs at the middle, indicating that the beam is, at this point, under no bending action. From this we reason that the design of the piece is based on the case of a beam half as long as the span of the bridge and supporting a load equal to half of the excess load assumed. Indeed a splice may actually be made at the middle of the span if desired. The batter posts and top chord are in compression, as if a half excess load were at each upper joint and the verticals are one in tension and one in compression, by an amount of half of the applied load.

The analysis of stresses in a queen post truss is then within the reach of anyone capable of handling simple problems in trusses, beams and joists. Just here, however, occurs one of those apparent discrepancies between theory and practice which tend to promote mutual distrust between the mathematical and the practical builder. The trouble here is that in the above discussion, which is substantially as given by most writers, the conditions assumed are not realized in usual construction. This is shown when we recall the details used, for the load is supported in turn by planking, floor joists or stringers, and transverse needle beams, while the iron rods which suspend the needle beam from the upper joint, merely pass through the straining beam and transmit no stress to it. If the piece is solid a hole is provided, or if it is built of two pieces the rod passes between them. Therefore the action is actually as shown in Fig. 3, the needle or cross beam sinking under its load and swinging clear of the straining beam, which tends to assume a shape due to an upward pull of the other vertical, and equal to the whole excess load. Fig. 3 shows the condition under which we should have to design our beam as one having the same span as the entire bridge and sustaining all the unbalanced load at one joint. That is to say, with both length and load twice as great as our engineering authors provide, for our beam is one-quarter as strong as before and we are no better off than if our bridge had been made by laying beams across the opening, with no trussing whatever. Fortunately we are able to vindicate the theory and by a slight change in detail to realize the conditions assumed by engineering authors in the discussion first given. This consists simply in arranging the vertical members to transmit compression as well as tension, which is done by inserting a post between the upper and lower members, thus forcing the straining beam downward under the weight and constraining it to take on the compound curvature assumed. (See dotted lines in Fig. 2.) A piece of about the section determined for the top chord is ample with any ordinary height of truss, giving us thus easily, four times the strength we have without a post. It is surely worth while to so strengthen bridges over which heavy loads are to pass.

The old highway bridge, built when large and sound timbers were easily obtainable, was formed of single solid members, framed together at the joints. These structures were not altogether economical or durable. Joints were apt to rot and details were wasteful, as for example, where a hole for passing an iron rod through a beam cut away a large fraction of its section. For such structural reasons, as well as for convenience in purchasing and hauling material, the use of built-up sections has been advisable. For instance, beams in all positions are best made of two or more flat pieces spaced by using packing blocks. This allows the passage of rods without any cutting, and this has been carried to the extent of making bridge trusses of 2-in. planks with 2-in. spaces between. The joints are then made by having the pieces of one built-up member pass through the spaces in the other and bolting through, thus saving any fitting.

Summing up the case of the queen post truss, it is believed that these points have been established: (1), that the strength is quadrupled by the insertion of posts; (2), that with posts in place a splice may be made at the middle of the span; (3), that the truss has well-defined and excellent properties. It also appears that theory and practice are apt to agree when both are closely examined.

REPORT OF THE COMMITTEE ON STRUCTURAL ENGINEERING.

Structural work during the past year has been fairly active. Plans are under way for steel buildings in Chicago that will require some 100,000 tons of iron and steel, and the Illinois Steel Co. is expending about $6,000,000 in improvements at its South Chicago works. Since the consolidation of the large structural iron works, a number of independent concerns have come into existence. In the main they have been successful and they show a steady growth. A greater specialization of the different classes of structural iron work is now being made between the shops, which is evidently working for the better interests of all concerned.

In Chicago there are under contemplation the following important works: A system of subways for street railways, the extension of the Illinois Telephone Construction Co.'s tunnels for freight transportation, a viaduct connecting the north and south side boulevard systems, and additional track elevation. The problem of reducing the excessive noise from elevated railways is being investigated, and for this purpose the City Council has appointed a special engineer. Among other schemes, it has been proposed to encase the steel structure with concrete and to support the rails on longitudinal timber sleepers resting on cushions of sand or asphalted felt. A large part of the noise in cities is a nuisance which can and should be prevented.

The largest bridge under erection in the State is the double track railway cantilever bridge over the Mississippi river at Thebes. This structure has a channel span of 671 ft. The total length is 3,807 ft. The approaches consist of concrete viaducts with arches of 65 and 100 ft. span. During the past year a number of bascule bridges have been erected. This style of structure is rapidly superseding the center-pier drawbridge for certain classes of navigable streams, of which the Chicago river is typical.

The construction of steel highway bridges is not yet carried out as scientifically or as systematically as is the construction of railway bridges. There is too wide a variance in the loadings and specifications for highway bridges. One firm reports that of 12 or 14 bridges, no two were alike and there was very little in common between them, notwithstanding the fact that the spans were often about the same. A great deal of difficult work could be avoided, and the cost of highway bridges lessened by the adoption of some uniformity of specifications and loadings and by accepting a number of simple standards covering different parts of a highway bridge. The standards should cover the following:

The most suitable and economical type of bridge for the span; the relation of depth of truss to length of span; the section of material for the truss chords and posts; connections of floor beams to trusses, and of stringers to floor beams.

During the past year members of this committee have had to deal with two cases where the floor systems of steel viaducts had been entirely destroyed by rusting due to the action of locomotive gases. The attention of city authorities is called to the necessity of careful inspection of steel structures over railways. In the cases of the viaducts referred to, the extent of corrosion became apparent only after complete failure of the floor stringers, which had long been in a dangerous condition. The rusting action had been going on over the entire surface until the web sections had become so thin as to be readily punctured with the finger, and yet to the observer from below the beams were apparently in safe condition. There is no paint which will afford any permanent protection against corrosion from engine gases. Attempts have been made to protect the iron with a coating of cement mortar, but the results have not been very satisfactory, owing to the cracking of the plaster. The Illinois Central Railway has covered the viaducts over its tracks in the Lake Front Park, Chicago, with terra cotta slabs. This is expensive, but the results are apparently successful, especially in this case where an ornamental structure was required. In renewing the floor systems of the viaducts referred to, the sections were increased 25% above what was required for strength, in order to allow for deterioration. In this connection we suggest that it is advisable in many cases in bridge work to use more compact sections, even at the expense of a reduced radius of gyration, as the effect of corrosion is directly proportional to the exposed surface.

The greatest advance in structural work during the past year has been in the increased use of reinforced concrete. This construction has now passed beyond the experimental stage. During the year the C., B. & Q. Ry., the C. & A. Ry., the Wabash Ry., the I. C. Ry., and others, have built a number of concrete-steel arches and culverts throughout the State. On the C. & W. I. Ry. and the Wabash Ry. bridge floors of reinforced concrete have been in use for over a year, giving entire satisfaction. The largest concrete-steel arch highway bridge in the State has just been completed at Kankakee. A ribbed concrete-steel arch of somewhat novel design has been built at LaSalle. Highway bridges of reinforced concrete are now being built at as low a cost as steel bridges. In direct competition at Waterloo, Ia., the bid on a concrete-steel bridge was lower than the bid for a steel structure. The contract price for a concrete-steel bridge at Michigan St., Indianapolis, was $25,770 lower than the lowest bid for a plate girder bridge.

A year ago the design of reinforced concrete beams was a subject of much difference of opinion. A great number of tests have been made on the strength of concrete-steel beams by the different engineering colleges and by the concrete-steel firms throughout the country and the results summarized into practical working formulas, so that engineers now have definite data upon which to design. In this connection your committee wishes to express its appreciation of the valuable work performed by the Engineering Experiment Station of the University of Illinois. Concrete-steel beams are being used largely for the floors of fireproof buildings. Among the more important structures which have recently been constructed with concrete-steel floors are the following: The Ingalls Building, Cincinnati, O., span of floor beams 16 ft.; the Gamble Building, Kansas City, Mo., 16.5 ft. spans; warehouse at 13th St. and Michigan Ave., Chicago, 15 to 20 ft. spans; building of the filtration plant at New Haven, Conn., 20 ft. spans.

There is still a very wide variation in the sections and the shape of concrete arches that have recently been built, even when the loading is the same. The factor of safety in these arches varies from 1 to 100, not only in different structures, but also in the same structure. Evidently there is much unscientific and irrational designing. Nowhere is the factor of safety so evidently a factor of ignorance. That arch failures are very rare speaks well for this type of bridge, but undoubtedly money has been wasted on an excess or an uneconomical distribution of material. The elastic theory as a rational basis for designing concrete and concrete-steel arches is now generally accepted by the most experienced engineers. The results of tests of full sized arches confirm this theory; but the cumbersome and tedious mathematical formulas have led the designer to seek one of the numerous ancient arch theories, and after finding that he can get any kind of a section he wishes by simply picking out and accepting a certain method, he very naturally throws aside all of them and proceeds to draw up his plans after some structure that suits his fancy. Recently several engineers have made investigations to find rules of variation, approximate methods or empirical formulas which are based on or give results conforming to the elastic theory of arches. A paper on such research was presented at the recent meeting of the American Association for the Advancement of Science at St. Louis. At the present time, work in this direction is one of the most important and valuable fields of research for the engineering profession.

L. K. SHERMAN, F. W. VON OVEN, C. W. MALCOM.

DISCUSSION ON CONCRETE BRIDGES.

MR. L. K. SHERMAN: The Kankakee bridge is the largest highway concrete bridge in the State, but from an architectural standpoint, in my opinion, it is far more artistic to make the intrados of an arch tangent to the piers and the abutments; I believe that the bridges which have gone down in history as handsome arches have been of that type, instead of having the abrupt angle at the springing line that the Kankakee arches show. One reason why we build these arch bridges is on account of their appearance, and I would suggest that in the nosing of the piers, instead of an angular or pointed section, it would be better to bring them out on a radial line. Such nosing of piers is more efficient as a cutwater, and in my opinion it corresponds better with the curve of the arch. Similarly the back of the piers I would round out on radial lines.

In regard to the designing of arches, a comparison of the sections of arches recently built will show that even where the loading and the span are the same, there is no relation between them. In other words, there does not seem to be any scientific harmony of designing. Most eminent bridge engineers have favored the elastic theory for the designing of arches, but the trouble is that the elastic theory is so wrapped up in a maze of complicated mathematics, that when a man looks at it he quits and looks around for a shorter cut, and will look around and pick out, say from Baker's "Manual of Construction," one of the dozen different methods for designing arches. He finds, as I did, that I could assume my arch section as I wanted it, and could then go to work and pick out a theory that would prove it was right. But I believe we are going to get out of that. One of the best things that has been brought up in this direction was a paper presented at the St. Louis meeting of the Association for the Advancement of Science. The writer accepted the elastic theory, but he devised certain empirical formulas that would give results that corresponded. I would suggest that for professors in engineering schools and for investigators in technical research there is not a better subject than this approximate method of the elastic theory as applying to arches. I think there is a hope for getting a theoretical and practical solution of design for arches, and I mention this elastic theory. Now that is beyond peradventure the one to go by. Not only from theoretical reasoning, but arches of 75-ft. span have been tested with loads by the Austrian Society of Engineers, and their report says that this theory is the only one that agrees with the practical results obtained.

MR. WATERBURY: Even the elastic theory has its faults when applied to concrete arches. For one thing it assumes that the deformation in concrete is proportional to the stress; this is not strictly true. It is more nearly true to say that the stress is proportional to the three-quarter power of the deformation. This is shown by various tests. However, within the limits within which the stress varies in concrete arches, it would probably be as accurate as are the common laws pertaining to material which we use, to say that the deformation is proportional to the stress. Prof. Howe has a very elaborate treatise on the elastic arch, which is about as complicated as any arch theory as far as mathematics is concerned. Another book which is much used in Cain's "Theory of Concrete-Steel Arches," giving a graphical solution based upon the elastic theory of the arch, which is about as easy a solution as there is. There have been methods of analysing reinforced arches worked out, based upon the elastic theory as given in Howe's book and Greene's "Treatise on Arches." One of these is by Mr. Colpits, who has worked out some tables for the solution of arches based upon the elastic theory. One trouble with Mr. Colpits' analyses, when applied to reinforced arches, is that he assumes that the deformation of the material is proportional to the stress. If the material were a homogeneous material, whether all concrete or all steel, that of course would be true or nearly so, but it is hardly true to say that the deformation throughout the section is proportional to the stress when we have two radically different materials, steel and cnocrete. I do not think there is any such error in Cain's work. Last year I had under my charge two investigations of arches. They were made according to Cain's theory, and I tried to obtain some check by Mr. Colpits, who has worked out some tables for the solution of about 300%. For plain concrete arches, Mr. Colpits' assumption would probably be correct.

MR. GREGG: In making the briquettes for the Kankakee bridge work, I used a stone dust which had passed a No. 30 screen. The screenings used in the concrete all passed through a ¼-in. screen at the crusher. This was mixed with 1½-in. or 2-in. stone.

MR. R. L. HUMPHREY: We are too prone to use a fixed proportion, with little regard to the voids in the materials used. Generally speaking, it is better to use a material graded from coarse to fine, rather than one composed of several sizes not well proportioned. Concretes are usually fabricated from stone of one size (¾-in. or more) and sand which is quite fine, and cement. Such a mixture requires a large percentage of cement to fill the voids and does not produce a dense mass. If we use the stone as it comes from the crusher, excluding the very fine dust, and add sufficient sand to fill the voids in the stone and use enough cement to fill the voids in the mixture (allowing a 10% excess of the latter) we will obtain a far better concrete. It is for this reason that gravels, free from organic matter or an excess of very fine material, make such excellent concretes. Such material is naturally well graded from coarse to fine, and when sufficient sand is added to fill the voids, you obtain a very dense mass and therefore a very strong one.

In Mr. Gregg's case, much better results could have been obtained if he had sized the 1½ or 2-in. stone down to the ¼-in. screen, and screenings in proper proportion to fill the voids, from ¼-in. down to the sand (No. 30 screen). Whatever material is used in concrete, the voids should be first obtained and from this determination the proportions should be fixed. If the stone has a high absorption, it should be thoroughly wetted just before use, thereby preventing the dry stone absorbing the water required for the proper hardening of the cement.

As to the degree of fineness to which cement should be ground, while it is true that 10% may be retained on a No. 100 sieve, at the same time the cost of this residue would not be any more than sand of average price; on the other hand, the cost of reducing the residue so that it would all pass the No. 100 sieve would add materially to the cost of the cement, and it is doubtful whether there would be a corresponding increase in the binding power. There is an economical fineness determined from the cost of the cement and the strength tests. In fixing the requirements for fineness, therefore, the engineer should be governed by practical rather than theoretical conditions. In reinforced concrete constructions, the engineer too often introduces or wastes metal where none or a very much smaller quantity is required to safely carry the loads. We build concrete structures and since concrete is deficient in tensile strength, and therefore its resistance to shear, it is necessary, therefore, to introduce sufficient metal to compensate for this deficiency, but only sufficient quantity and at the points required.

MR. GREGG: The gentleman misunderstood me. We used as screenings all that would pass through ¼-in. mesh. All the stone are not 2-in. or 3-in., but are graded from 3-in. down to ¼-in., and from ¼-in. down to the dust was used with sand. The concrete was tamped in layers of 6 to 8 ins., and we used shovels, with the blades flattened. The facing was spaded until fine mortar would come up to the surface of the concrete, and after the forms were taken off, we used a mortar of Portland cement, and 1 screenings that would pass through a 50-mesh sieve. That mortar was put on with a brush, and then rubbed in with a piece of grindstone, until we secured a very smooth surface.

MR. BURDICK: There was recently completed at Des Moines a Thacher arch bridge similar in construction to the Kankakee bridge. The roadway is quite high, necessitating a considerable depth of filling. Soon after the filling was placed, a crack developed parallel with the roadway, and about in the center of the roadway, the arches apparently having sprung outward, due to the pressure of the filling.

MR. GREGG: We used transverse bars one above the other, spaced about 4 ft. apart. This would prevent any separating of the longitudinal sections. In putting up the partitions or forms for the longitudinal section, we beveled sticks 2x4 ins., and laid them on the frames. This would leave a groove and the next section would form a tongue in the groove. The cost of the bridge, exclusive of pavement and sidewalk, was $45,470. It was taken as a lump sum.

REPORT OF THE COMMITTEE ON ARCHITECTURE.

No remarkable changes in architectural design or practice have occurred during the year, but an unusual amount of building has been done throughout the entire State, and this work has generally been better and more expensive than usual. The number of large fireproof office buildings erected in Chicago during the year is surprising, and still rents of offices in firstclass buildings are constantly increasing. This is certainly remarkable, for business is generally seriously affected by political uncertainties in the year of a presidential election.

The cost of all kinds of building lumber continues to rise, showing that a radical change in the current method of construction must soon be made, and that it may soon become possible to erect fireproof structures with due regard to relative economy. As usually happens, increased cost of materials, labor, and fixtures, seems to have but little repressive effect on building enterprises, so long as money is abundant and cheap. But any panic or failure of confidence in business circles would promptly stop all projects for new buildings.

Some very interesting experiments made recently at the Engineering Experiment Station of the State University give more complete data than have been hitherto available for determining the actual strength of armored concrete beams of large size. This system of construction now certainly promises to be less costly than and equally efficient as the hollow tile system of fireproofing usually employed in city office buildings. The reduction in price of American Portland cement and the successful improvement in quality, uniformity, and reliability of the product, appears to show that concrete strengthened by steel will eventually make it possible to construct fireproof schools, churches, and even houses within the permissible limit of cost. There is, however, still some doubt concerning the behavior of this concrete construction when exposed to a hot fire and heavy streams of water in case of a fire in a large building. Therefore architects are disposed to be conservative in using the new system before it has passed through the ordeal of a severe fire.

The use of hollow concrete blocks is certainly increasing rapidly in different parts of the State, and good results have been obtained where proper care has been exercised in making the blocks. Perhaps the greatest objection is that a competent architect is seldom employed to design the building with proper regard to the nature of the material, so as to make it as effective and appropriate, avoiding the "machine-made" look as much as possible.

A satisfactory substitute for wooden floors, which would be incombustible, sufficiently elastic, germ-proof, and pleasing in appearance, is a pressing need. When this is found it would produce a great advance in the sanitation and comfort of our houses, offices, and other buildings.

The license law for architects still produces satisfactory results and is generally acceptable to the architects of the State. It has certainly contributed much to improve the status of the architect before the public, and it has materially elevated the average educational attainments of the professional architect. Of the 700 persons originally licensed to practice because they were actually in practice at the time the law became effective 7½ years since, nearly two-sevenths have abandoned practice and have been replaced by over 150 persons who have passed the required examinations. Before the end of the next 20 years, all architects practising in this State will have passed the examinations, thus placing the profession upon at least an equal footing with any other.

N. C. RICKER, F. OSWALD, S. A. BULLARD.

NOTE—A discussion on the Architects' licensing law will be found with the discussion on the surveyors' licensing law, on page 53.

SCHOOL HOUSE CONSTRUCTION.

BY F. OSWALD (MEMBER).

1. Choice of Site. In selecting a site for a school house, choose a location that is dry, reasonably level, and not on the main business streets, removed as far as possible from railways, factories, workshops and stables. The healthfulness of the location should be carefully considered. The approval of the district physician, of the sanitary official, or of the board of health should also be secured. The area of the site should at least be sufficient to prevent shade from adjoining buildings. The space for the recreations of the pupils should be generous, and it should have a pavement of brick or concrete, with its surface inclined toward traps connected with the sewer. Where it is necessary to locate a school on a frequented or a narrow street, it should be placed near the rear of the lot with the yard next the street, and this should be laid out with walks, lawn, and shrubs; the school premises should be enclosed by an iron fence, not less than 4 ft. high. The play grounds should be screened from view of the street. It is often recommended that the borders of school yards and play grounds be planted with shade trees, but these must not be less than 25 ft. from the building.

2. General System of Construction. A school building with a seating capacity of less than 400, or one not over two stories and basement in height, may be built of ordinary construction. Buildings with a seating capacity of 400 to 800, or which are not over three stories and basement in height, should be built of slow-burning or fireproof construction. School buildings that seat more than 800 pupils, or which are more than three stories and basement in height, should be entirely fireproof. Smaller school buildings, only one or two stories in height and not containing more than four class rooms, may be constructed of wood, but the internal woodwork should always be coated with fireproof paint.

3. Details of Construction. Foundations should be so constructed and proportioned that the pressure upon the soil beneath may not exceed the safe limit for the particular kind of soil. Mixed clay and sand, if wet, should not be loaded with more than 3,000 lbs. per sq. ft., but if in thick beds, dry and thoroughly compressed, it may be loaded up to 4,500 lbs. per sq. ft. If concrete foundations are used, without the insertion of steel beams or rails, they must not be loaded more than 8,000 lbs. per sq. ft. If reinforced by steel beams, these must be so adjusted that the fiber stress in the steel may not exceed 16,000 lbs. per sq. in. Dimension stones for foundations and walls, set with full beds of cement mortar and well tamped, may be loaded up to 10,000 lbs. per sq. ft. If the beds of the stones

are dressed to plane surfaces and the stones are set in first-rate cement mortar, this loading may be increased to 14,000 lbs. per sq. ft.

Rubble stone walls are to be built of approximately rectangular stones, with flat beds, carefully bonded lengthwise and into the wall, with full mortar beds, and the external surface of the wall should be rendered approximately water proof by a coating of good Portland cement mortar. The use of soft brick must be prohibited in all parts of buildings exposed to weather and also in internal piers. Pressed brick work in walls laid in standard Portland cement mortar must not be loaded more than 25,000 lbs. per sq. ft. Brick work laid in ordinary lime mortar must not be loaded more than 13,000 lbs. per sq. ft. Floors for class rooms and the stairway halls should be so constructed as to support their own weights in addition to the weight of any partitions or permanent fixtures that may be placed on them, an additional live load of 80 lbs. per sq. ft. For auditoriums and assembly halls this live load should be taken at not less than 150 lbs. per sq. ft. of floor.

4. Design. It is of the greatest importance that the architect should consider the comfort, safety and health of the pupils, and especial attention should be paid to the lighting, heating and ventilation. In addition to the main entrance, there should be separate outside entrances to the basement for each sex, and there should be not less than two exits from the first floor, and not less than two separate staircases from the first to the upper floor. There should be a vestibule of sufficient dimensions to shelter early pupils before admission to the building proper. Basement entrances are also generally arranged for giving pupils access to play and toilet rooms before the beginning of school exercises. All entrance doors should open outward to prevent disaster in case of fire or panic. This is required by law, but it is generally neglected. The minimum width of a corridor is 10 ft., and should be as well lighted by windows as the plan and an economical construction of the external walls permit. For buildings exceeding two stories and basement in height, the stairs should be constructed of masonry or protected metal throughout, their under side being wire lathed and plastered. Treads of iron stairs should be covered with rubber mats; for primary schools the steps should have 6½-in. with 12-in. treads. The stair railing should be plain and without openings, 3 to 3½-in. handrail. On the wall side a 2-in iron pipe firmly fixed to the wall will suffice as a hand rail. Staircases should not be wider than 4 ft. in the clear, so that only two files of pupils can pass up or down, each provided with a handrail; this is to prevent any crowding between the files in case of panic or fire. Circular stairs must never be used in schools or other public buildings. Steps should never be placed in landings between flights or to form short flights of but few steps. Classroom windows should be from 36 to 40 ins. wide, and the window sills usually 3 ft. above floor; many teachers recommend that the window sill be placed 4 ft. above the floor, in order to prevent the pupils from

looking out when seated, and the top of the window should extend as near the ceiling as the finish will permit. A transom in the window is objectionable, as the deep bar obstructs the light, and casts shadows in the room. Windows evenly distributed in the side wall diffuse the light better than a great mullioned window of equal glass area placed in the center of the wall, this arrangement leaving the corners of the room in shadow. There is no objection to the use of mullioned windows, if the light be so ample that none of the desks are shadowed, providing that the building be so constructed that the proper internal temperature may be maintained, when so large a glass area is used. Where arched windows are used, the height of the rooms should be increased, the glass area being counted only for the rectangular portion of the window meeting the arched head. By double glazing nearly 50% of the heat passing through single glass can be saved. The two panes must be thoroughly clean and dry and be set 1 in. apart if possible. Double sets of sash prevent much waste of heat through the windows and are more effective in checking the drafts through crevices and in shutting out dust and noise. In considering any additional thickness of brick walls, the cost of each additional 4 inches in the thickness of the external brick walls of a school building will increase its cost 4 to 5%. Basement windows should not be less than 4 ft. high between sill and lintel. The height of basement should not be less than 10 ft. in the clear for the proper installation of the heating apparatus. Proper ventilation requires about five times as much heat as the quantity let through walls, windows, ceiling and floors.

The basement floors should be of solid concrete or cinder filling for gymnasium and play rooms. A coat of hot asphalt or tar concrete may be laid on the concrete if placed on damp soil. The basement must have separate toilet rooms for boys and girls; these should adjoin the play rooms and be readily accessible from the school yard. Where space permits, the basement may well be utilized for gymnasium, baths, cooking and manual training, classes, etc. In large school buildings, the boiler and coal room should be placed in a separate building, provided that the size of the lot permits this arrangement.

All floors above the basement floor in large schools should be fireproof. Mill construction of heavy timbers has the disadvantage of shrinking and cracking. As the market seldom affords seasoned timbers of large dimensions, it therefore appears advisable to use steel beams with large arch construction of concrete or hollow tiles. In case wood joists are used, it is necessary for all ceilings to be wire or metal lathed as a fire protection and for greater durability of the plastering. The principal danger from fire is from the basement. With the first floor constructed of incombustible or slow burning materials, with all internal partitions of masonry construction, with the plastering laid directly upon hollow brick external walls, and with wire lathed ceilings, if the basement is isolated from the first floor by self-closing and metal-covered doors, all fires being confined to the basement, even if the upper floors are constructed of ordinary wooden joists with 7/8-in. floor boarding and deafening mortar, there is little risk to the lives of the pupils if a proper fire drill is not neglected. To minimize danger from panic and give greater security to the inmates, it is advisable that floors of buildings exceeding two stories in height should be built entirely of incombustible materials. All floors between school rooms should be mortar deafened 2 ins. in thickness, bringing the mortar level with top of joist; when deafening is dry, place a layer of waterproof wool felt upon the mortar, and lay the floor upon this.

It is well understood that 50 pupils are the maximum number that one teacher can properly look after and instruct in a room. With this as a basis, the size and shape of the school room should be arranged to accommodate 50 pupils and their teacher. A single seat and an aisle occupy 40 ins., 20 ins. each for the desk and the aisle, and there should be a 36-in. aisle on each outer side of room next the wall. Six files of seats require a room 23 ft. wide; eight rows of seats give 48 seats, and with a 4-ft. aisle at the rear, and 6 ft. space for the teacher's desk, the room would be 34x23 ft. This makes room of good shape, and being a little longer, it is more easily lighted than a square room. The height of the room should not be less than 12 ft. It is not necessary, where an efficient system of ventilating is installed, to make the room as high as it would be where ordinary ventilation is employed. The old custom of building schools with very high ceilings was to cause the room to contain a large amount of air for the children to breathe, but with proper ventilation the school room ceiling can be 2 ft. lower than was formerly considered necessary, thus saving this height in each story, which saving will more than pay for a good system of ventilation.

The daylight should enter the room from the left of the pupil when seated, and the windows should be all in the long side of the room, with a few half windows near the ceiling at the rear, provided that the plan permits the rear to be an external wall. The best authority on the lighting of school rooms requires that the amount of glass surface for each room should equal a least one-sixth of the floor area or not less than 130 sq. ft. for a room of 750 to 775 sq. ft. of floor area. Prussian laws require the glass surface to equal one-fifth the floor area. The teacher's desk should be located at the end of the room next the door. The blackboard should be placed along the ends and the side of the room opposite the windows.

The system of heating and ventilation usually employed in a good school building consists of a series of fresh air and vent flues arranged side by side, separated by brick or metal partitions, each room being provided with its separate fresh air and vent flues. A sufficient area of steam pipe surface is placed in the fresh air room or chamber directly under each fresh air flue to heat one room. The vent flue is located adjacent to the fresh air flue and has its inlet opening at the floor line, and it then extends up through the roof to a point above the highest part of the building. The opening in the fresh air flue is about 8 ft. above the top of the floor; in this manner the foul and colder air will be removed from the room and discharged through the vent flue. Besides this indirect steam heating system, there are direct systems of heating by steam or hot water. The direct steam heating has some advantages over the indirect steam or hot air system. When direct radiators are set before or beneath the windows and near the greatest exposure, thus warming the room more uniformly. In American schools, the accepted standard of fresh air supply is 30 cu. ft. per minute for each pupil, which must be heated in zero weather sufficiently to maintain a temperature of 70° F., the maximum temperature to be permitted in a class room. Rooms are frequently overheated, the temperature being in winter from 72 to 76° F. Direct steam heating is efficient for heating, but it supplies no fresh air. Hence indirect steam heating for class rooms and direct heating for halls should always be employed, although more expensive. Hot water heating is more costly to install than steam heating, but is much more durable.

There are two systems of ventilation: 1, By gravity, where the movement of the air is caused by the different densities of the warm air in the flues and of the cold air outside.

2. The mechanical system, when the air is moved by fans, driven by steam or gas engine, or by an electric motor. The mechanical system is alone certain to supply the required volume of fresh air per pupil, when of proper dimensions and installed by a competent maker. The usual gravity system supplies generally but a small portion of the fresh air neded, so that the windows are frequently opened to make up the deficiency, at the risk of producing cold draughts in the class room.

For example, take the class room 23x34x12 ft., containing one teacher and 48 pupils. Volume fresh air per hour=49×1800= 88,200 cu. ft. Capacity of room=23x34x12=9384 cu. ft. Then 88,200÷9384=9.4, which shows that the air in the room should be changed 9½ times per hour. It is changed much less frequently in most class rooms, which shows that school rooms are very poorly ventilated, and that preventable diseases may be caused thereby.

School boards, and others interested in school construction, should recognize that no great saving in cost can usually be made, except by the sacrifice of desirable features, and that the permanent value of a building depends upon the knowledge, skill and forethought employed by the architect in the disposition of its parts, in the durability and fire-resisting character of its construction; in the quality and sufficiency of its appointments and fittings; and, finally, that mere beauty of design, though no small consideration, may fittingly be restricted within the limits possible to attain in brick construction.

The difference in cost between a school building designed with due regard for architectural effect, and one of a purely utilitarian construction, is not great. With ordinary construction, a satisfactory architectural result may be obtained at an increase of cost not exceeding 5% more than that of merely plain construction. Careful estimation of the cost of building and economy in planning certainly produces a well balanced arrangement of rooms, and except in rare cases, avoids an irregular disposition of the plan. The soul of the external expression of a school building is the size, distribution, and form of its windows, according to what experience has shown to be best adapted to the needs of the class rooms. Ample scope is given to the designer in his treatment of the roof and in the masses and the proportions in which he may model the structure without impairing its utility; in the variation of the texture and the color of brick work; in the use of differently colored mortars; in the variety of detail; in the subdivision and the accentuation of the surfaces opportunity for individual expression is thus offered without the sacrifice of any practical requirements.

DISCUSSION.

MR. RICKER: In the double windows it is difficult to get the glass an inch apart. The minimum suitable thickness of the stratum of air is doubtful. Perhaps ½-in. may do; ¾-in. is ample. Usually sash is made of 1⅞- in. lumber, and in sashes made to hold the double lights there is about ½-in. between them. Theoretically you save more of the heat that passes through the window than Mr. Oswald has stated, for nearly half of the heat that would pass through a single light is saved by putting in the second light. A third light would save three-quarters of the heat passing through the first, and a fourth one would save seven-eighths of it, but it is not economical to use more than two thicknesses of glass. I noticed in Germany 30 years ago that the houses all had double windows, but they almost invariably had an outside sash with a single thickness of glass, this sash being rebated on the edges and fitted in close to the window recess opening. The sash is often made tight by putting in strips of cloth to make it airtight, and it is held in place by four hasps hooked into eyes built into the jamb of the opening. This is very efficient, but prevents all ventilation through the window. At that time less attention was paid to ventilation. The double glass sash window can be opened when necessary.

THE CHICAGO PARKS.

BY A. C. SCHRADER (MEMBER).

For the extension of its park system the city of Chicago has authorized the issue of $6,000,000 in bonds; $4,000,000 by the South Parks; $1,000,000 by the West Parks, and $1,000,000 by Lincoln Park. These three divisions, with the exception of a few small squares controlled by the city, constitute the entire park system, and these bond issues are a tax upon the several sections of the city in which the park systems are located. On account of legal difficulties nothing has been done by the West Parks. The Lincoln Park Commissioners have sold bonds for $1,000,000 for an extension northward. This area will be developed by filling in the lake shore rather than by the condemnation of lands adjacent. It is in the South Park system that the greatest activity has been shown: 12 new park sites have been selected, and plans have been drawn for their improvement. They vary in size from 4.95 acres to 322.68 acres, the total area being 627.24 acres. Grant Park comprises 40 acres of existing park west of the Illinois Central Ry. (now known as Lake Front Park), and 161 acres of made land east of the railway.

The total area of the South Park system is 2,175 acres, embracing 1,858 acres in the parks, and 317 acres in the boulevards, which are 17.28 miles in length. The West Park system contains 1,001 acres, 614 acres being in the parks, and 387 acres in the boulevards, which are 23.14 miles long. The Lincoln Park system has 425 acres, including 318 acres in its parks and 107 acres in the boulevards, which are 9.22 miles long.

	South Division	WestDivision (not includ'g Jefferson)	North Division	Jefferson	City as a Whole
Total area of city; acres...	66,088.32	22,800.	12,640.	20,480.	122,008.32
Total population of city	737,255.	822,701.	342,470.	59,825.	1,962,251.
Average population per acre.	11.15	36.08	27.09	2.92	16.08
Total area of parks; acres	1,974.86	651.72	536.35	16.86	3,179.79
Average population to each acre of park.	373.31	1,262.35	638.52	3,439.02	617.10
Park area per capita of population; sq.ft.	116.68	34.50	71.14	12.27	70.58

In 1903 the assessed valuation of the South Town was about $254,000,000, the rate of park taxation being 5 mills; that of the West Town was about $90,000,000, the rate of park taxation being 8.47 mills; and that of the North Town was about $55,000,000, the rate of park taxation being 8.87 mills.

Mr. Bion J. Arnold, in his report on the traction problem of Chicago, makes some estimates of the probable future population of the city. Starting with the year 1902 at 2,000,000 and the rate at 7%, the population in 1952 would be about 13,250,000, or if the rate is 3%, the population would be 5,250,000 in 1952. The study of the curves representing the increase of population deduced by Mr. Arnold for London, Berlin, Paris, New York, Philadelphia and Boston inclines one to the opinion that the lower rate (3%) is much nearer the rate of increase than the higher rate (7%) and that the final result will fall between them.

In outlining the desirable features for a small park or playground, I cannot do better than quote from a paper by Mr. J. Frank Foster, engineer and superintendent of the South Park system, read before the Chicago Society for School Extension:

> As to what a city playground should be, the idea of making it a park should be abandoned. The playground is essentially the thing. If it were possible, in each place where it is now likely there will be located a playground, there could be constructed a 40-acre park, which would include all of the playgrounds which it is thought would be desirable. But the cost would be prohibitive, at least at this time. But each playground should be not less than 10 acres in extent. Each playground should have a ball field, which, if possible, should be large enough for the accommodation of two games. Running tracks should be provided; sand-pits, a swimming pool, a wading pool for little children, where they can sail their toy boats, and an outdoor gymnasium. In addition there should be a building which would be suitable for indoor gymnastic work, which could be used during the winter. The building should be of sufficient size and so constructed as to have quite a good sized hall for public lectures and other entertainments, and suitable rooms for girls' and boys' and men's clubs and for other purposes. The building should be the social center of the community, and open every day and evening during the year, and always at the disposal of the people for proper purposes. Where possible the outer area of the playgrounds should be planted with such shrubbery and trees as can be made to thrive in the locality. In many places little can be accomplished in this way, because of the extreme difficulty in making plantation live under the conditions that exist in many thickly populated sections of our city, as to smoke in the atmosphere and gas in the earth. But something can usually be done in this direction, and what can be done should be done, because, if there are any who should be surrounded by beautiful things that can be given them, they are those for whom the playgrounds are to be created. All playgrounds should of course be provided with suitable caretakers and directors of games.

Ten of the 12 new parks, I understand, are nearly completed by the South Park Board, and the ideas presented above by Mr. Foster have, to a large extent, been observed in their construction. The field houses are constructed of concrete, with tile roof, and vary in size. Their cost varies from $60,000 to $100,000. The exterior of the concrete walls is left rough. Concrete pilasters and pillars with classic capitals serve to ornament the buildings. In the near future it will be interesting to note to what extent these monolithic walls will crack.

The lake shore protection works for Jackson and Lincoln parks may be of interest. At Jackson Park, the breakwater consists of two rows of piles and oak stakes about 7 ft. apart filled in with cedar bark, and covered with a pavement of limestone blocks. Back of the breakwater is deposited sufficient sand to produce the required formation, upon which to place the limestone or granite block pavement. The pavement has a curved surface and an average width of 40 ft., and the blocks average 12 ins. in depth. Immediately adjacent to the upper edge of this pavement is placed a concrete walk 12 ft. wide, and next to this walk is placed a 50-ft. drive. The cost is about $25 per lineal foot, not including the sand filling. At Lincoln Park, Wakefield sheeting is used in the breakwater, concrete floor in place of stone block pavement, and a straight line section instead of a curved one.

The proper connection of the South Park system with the Lincoln Park system across the Chicago river in the vicinity of Michigan Ave., is proposed and I understand that the plan receiving favorable consideration at this time comprehends a bascule bridge across the Chicago river, connecting a broad boulevard approach from the south, located about 100 ft. east of Michigan Ave., and extending north to Chicago Ave., connecting with Pine St.

We should begin to plan for an outer park system and prepare to acquire the land before excessive prices are reached. The sites which have been suggested are the valley of the Des Plaines river from Riverside northward, the Skokie marsh, the high lands near Willow Springs, and the Calumet region. Suggestions have also been made that a portion of the Chicago river frontage near the center of the city be beautified. The writer wishes to particularly emphasize the desirability of improving the lake front and using it for public pleasure grounds, and by this he does not mean simply the limited district included within Grant Park, but the entire frontage extending from Jackson Park to Lincoln Park, and east of the railway tracks, which would be crossed by bridges:

DISCUSSION ON PARKS.

MR. NELSON: We have had a paper on the drainage of lakes in Iowa. From a landscape gardner's point of view, that is a great mistake. While they may have an advantage from a commercial point of view, from an artistic point of view they must be of far more value to the people of Iowa as lakes than they could possibly be by adding a few more to its already great number of acres producing grain.

MR. HARTMAN: The city of Peoria has availed itself of the Illinois law which was passed several years ago, to purchase three large tracts of land, of 100 to 200 acres each, and has improved two of them, which are now very creditable parks. And the people take a great deal of interest and pride in the parks, and appreciate them a great deal. As to the drainage of the lakes of Iowa, all the meandered lakes and ponds of Iowa are State property inside of the meander lines, but there are large tracts of valuable land there that can be drained without affecting in any way these lakes, some of which are very shallow, and would properly be classed as ponds or sloughs. A special act was passed pertaining to the drainage of meandered lakes, providing that whenever 100 residents or property owners of the county petitioned that a lake should be drained, the Governor should appoint a commission to make a survey and investigation of this lake, with recommendations as to whether it should be drained for agricultural purposes, or retained as part of the public domain.

MR. C. DUNN: At Peoria we have now Glenwood Park, Bradley Park and Madison Park, and the design contemplates a boulevard system running between these parks. Last year we spent a great deal of money on a driveway along the river on the brow of the bluff leading up from Naperville to Prospect Heights, the highest point along the river.

MR. TRATMAN: The new Grant Park in Chicago is an interesting piece of land. Here, as in many other cities, the railways and manufacturing industries had practically monopolized the water front, which is the great breathing spot, and for many years Lake Front Park, along Michigan Ave., was shut off from the water by railway tracks. After much litigation between the railway and the city, the latter acquired the right to establish a park east of the track. A bulkhead was built 800 ft. out in the water, and for some years they have been using the enclosed space as a dumping ground for the city refuse, until now it is nearly completed. It is now simply waste ground, but when graded and surfaced and finished up as a park, it will be a very beautiful place.

THE SHERIDAN ROAD.

BY W. S. SHIELDS (MEMBER).

When death swings wide the door and a great man passes through leaving to us a heritage of high ideals, works accomplished for the betterment of man, and enterprises begun, which generations yet to come may complete and enjoy, we stop and consider what manner of man this was who accomplished so much and did it so quietly. Such is the life that not only in the end, but all the way down is worth the living. Such was the life of Volney Foster, who forseeing the needs of the great multitude of men and women shut up at their daily tasks throughout the long week, stopped to plan a way by which to make it possible for these people to get out of the city and away from their cares for a few hours and enjoy the beauties of nature. The result of this thought was the Sheridan Road.

In 1887, this man saw the advantage and conveniences of a great pleasure drive for the people of Chicago and from this thought came the plan of the Sheridan Drive, which is ultimately to connect the cities of Chicago and Milwaukee and perhaps pass on to the north and south of these cities. Some-men called his project a dream, but having a store house of energy and ability, while holding himself personally responsible for the success of the enterprise, he brought to his assistance men of wide influence. Thus great progress was made. Streets already improved were set aside for this purpose, and a drive 100 ft. in width was opened up and improved from the north line of the then limits of Chicago to Evanston. In 1888, when seeking legislation from the State, he wrote Gov. Altgeld: "I am deeply interested in this project, but just why I cannot tell nor do I care to take the time to find out." In 1899, he secured from he late Archbishop Feehan a 100-ft. strip through Calvary Cemetery and in the first three years of his efforts saw the road opened from Chicago to Evanston. From this point north the progress was not so rapid, but interest was awakened and local committees set at work in Wilmette, Winnetka, Highland Park, Lake Forest and Lake Bluff. Before his death, which occurred in Chicago on Aug. 15, 1904, Mr. Foster had the satisfaction of seeing the Sheridan Road opened as a pleasure drive from Lincoln Park to Lake Bluff. One of his latest important achievements was the securing in 1900 from the Secretary of War, Mr. Root, an order which not only opened to the public as a pleasure drive the completed portion of the principal military road in Fort Sheridan, but secured the completion of the road through the unimproved portion of the reservation.

Sheridan Road bears the name of General Phil Sheridan, whose equestrian statute stands in Lincoln Park at the southern terminus of what is one of the most popular and widely known pleasure drives in America. It has natural beauty which if properly developed will form the background of a pleasure drive worthy of Chicago, but although the drive is now continuous and improved to Lake Bluff, it is far from what it should be and what its promoters intended it to be. New and better pavements and bridges are required, the roadbed is too narrow and the ravine grades too steep in some places, and there are many jogs and turns to be eliminated, trees to be planted and parks to be established, improved and beautified.

From Lake Bluff there is a break in the continuity of the road to Waukegan; through Waukegan and on north along the old Indian trail and skirting the lake, it extends through Zion City and Winthrop Harbor to the State line, although but little improvement has been made north of Waukegan. From the State line north through Kenosha and Racine to Milwaukee, little has been done towards locating the road. At the time of his death, Mr. Foster was planning to renew negotiations and to seek the passage of some laws in Wisconsin that would enable the friends of the road to have it completed into Milwaukee.

Mr. Foster was President of the Sheridan Road Association, and the Secretary was the late Alexander Clark, whose persistent and continuous efforts made success possible. To these two men belong the credit and honor of the enterprise, and their sudden deaths following each other so closely, was a serious loss to the Association.

Chicago is planning to spend millions of money to extend and beautify her park systems, and properly so; but here is an enterprise worthy of equal consideration. Here is an opportunity for men with means to leave to posterity some legacy. Monuments commemorative of historic events, or statutes of noted persons may be erected, and drinking fountains for man and beast should be found at frequent intervals. Across the ravines now spanned by cheap pile bridges should be memorial structures of artistic design and permanent construction. Here is also an opportunity for men of ambition and energy to do something for the public welfare. The enterprise is at a critical period in its history. It needs wise and experienced councellors, men who will not hesitate to go down into their purses, and who are willing to do hard work for public good and stand sturdy under unjust and jealous criticisms.

RAILWAY GRADE CROSSINGS.

BY F. G. EWALD (MEMBER).

In this paper it is proposed to present some statistics, and the laws bearing on the construction and protection of railway grade crossings in Illinois. To give a better understanding of the character of the various grade crossings, I will refer to them as Class "A," where the track of steam railways cross each other; Class "B," where the tracks of electric or cable railways cross the tracks of steam railways; and Class "C," where the tracks of electric and cable railways cross each other.

In Class "A," there are 526 grade crossings, having 1,338 crossing frogs. Each crossing might consist of two railways only, or it might consist of several. Of this number, 215 crossings are provided with protective devices, and operated under authority of the Railroad and Warehouse Commission. In Class "B," there are 392 grade crossings, having 1,367 crossing frogs. Of this number, 19 crossings are provided with protective devices as follows: Protective devices of 5 crossings are included in the number given for Class "A"; 3 more are equipped with protective devices and operated under authority of the commission; 11 more are equipped with protective devices but are not operated under authority of the commission. The total number of authorized interlocking devices at grade crossings is 218. For Class "C," I am unable to furnish any data at this time.

The Act creating the Railroad and Warehouse Commission was passed April 13, 1871. To the duties and powers prescribed in this Act, there was added another section (Act of June 16, 1887), which requires the commision to investigate the cause of any railway accident resulting in the loss of life or personal injury, which in their judgment, shall require investigation. This commission, as will develop later on, has jurisdiction governing the protection of trains operating over crossings and drawbridges. Section 12 of the Act of March 31, 1874, as amended, and Section 38 provide as follows:

Section 12. All trains running on any railroad in this State, when approaching a crossing with another railroad upon the same level, or when approaching a swing or draw bridge, in use as such, shall be brought to a full stop before reaching the same, and within 800 ft. therefrom, and the engineer or other person in charge of the engine attached to the train shall positively ascertain that the way is clear and that the train can safely resume its course before proceedings to pass the bridge or crossing.

Section 38. This act shall not apply to horse cars or street railways.

The next legislation in regard to railway crossings was passed June 3, 1887, and provides as follows:

Section 1. When and in case two or more railways crossing each other at a common grade, or any railway crossing any stream or harbor by swing or drawbridge, shall, by a system of interlocking and automatic signals, or by other works, render it safe for engines and trains to pass over such crossing or bridge without stopping, and such system of interlocking and signals, works or fixtures shall first be approved by the Railroad and Warehouse Commissioners, or any two of them, and a plan of such interlocking and signals designating the plan of crossing shall have been filed with such Railroad and Warehouse Commissioners, then it is hereby lawful for the engines and trains of any such railway or railways to pass over said crossings or bridge without stopping. * * * Provided, that the Commissioners shall have power in case such interlocking system, in their judgment, shall by experience prove to be unsafe or impracticable, to order the same to be discontinued. (As amended by act approved May 28, 1891. In force July 1, 1891.)

Section 2. The commissioners may appoint a civil engineer to examine such proposed system plans, and report the result of such examination, and said commissioners are hereby authorized to allow $5 per day as compensation for the services of such civil engineer, or such reasonable sum as such commissioners shall deem fit. * * * And the said commissioners are also empowered on application for their approval of any such system of interlocking and signals, works or fixtures, to require of the applicant security for such fees, costs and expenses.

Next follows the Act of May 27, 1889. It deals with the construction of future crossings where there is a disagreement among the contending parties as to the place and manner of crossing.

Section 1. Be it enacted * * * that hereafter any railway company desiring to cross with its tracks the main line of another railway company, shall construct the crossing at such place and in such manner as will not unnecessarily impede or endanger the travel or transportation upon the railway so crossed. If in any case objection be made to the mode or place of crossing proposed by the company desiring the same, either party may apply to the Board of Railroad and Warehouse Commissioners and it shall be their duty to view the ground and give all parties interested an opportunity to be heard. After full investigation, and with due regard to safety of life and property, said Board shall give a decision prescribing the place where and the manner in which said crossing shall be made, but in all cases the compensation to be paid for property actually required for the crossing and all damages resulting therefrom, shall be determined by law in case the parties fail to agree.

Section 2. The railway company seeking the crossing shall in all cases bear the entire expense of the construction thereof, including all costs and incidental expenses incurred in the investigation by the Board of Railroad and Warehouse Commissioners.

The next and last enactment bearing on railway crossings was passed June 2, 1891. It provides for protection at crossing by the installation of interlocking devices.

Section 1. Be it * * * that in every case where the main tracks of two or more railways cross at grade in this State, any company owning or operating any one of such tracks, whose managers may desire to unite with others by protecting such crossings with interlocking or other safety devices, may file with the Railroad and Warehouse Commission a petition stating the facts of the situation, and asking said commission to order such crossing to be protected by interlocking signals, switches, or other safety appliances. Said petition shall be accompanied by a plat showing the location of all tracks; and upon the filing thereof, notice shall be given to each other company or person owning or operating any track involved in such crossing, and the said commission shall thereupon view the site of said crossing and shall, as soon as practicable, appoint a time and place for the hearing of such petition.

Section 2. If the commission shall * * * have cause to believe that any such grade crossing, as described in Section 1, is dangerous to the public or to persons operating trains, and requires protection, then it shall be the duty of said commission, without any petition, and of its own motion, to cite the several companies owning or operating the railway tracks forming such crossing, to show cause why they should not be required to provide such crossing with interlocking or other safety appliances.

Section 3. At the time and place named for hearing under Sections 1 or 2, unless the hearing is for good cause continued, said commission shall proceed to try the question whether or not the crossing shall be protected by interlocking or otherwise, and shall give to all companies and parties interested an opportunity to be fully heard. Said commission shall, after such hearing, enter an order denying the petition or discharging the citation if the protection of such crossing as proposed is deemed unnecessary. If said commission shall be of opinion, from the evidence and facts produced, that the public good requires that such crossing be protected, then the commission shall enter an order prescribing an interlocking device or equipment for such crossing; in case the companies interested cannot agree upon a device, in which order shall be specified the kind of machine to be used, the switches, signals and other devices or appliances to be put in, the location thereof, and all other matters which may be deemed proper for the efficient protection of such crossing, and said commission shall further designate, in such order, the proportion of the cost of construction of such plant, and of the expense of maintaining and operating the same, which each of the companies or persons concerned shall pay. In case, however, one railway company shall hereafter seek to cross at grade with its track or tracks, the track or tracks of another railway company, and the Railroad and Warehouse Commission shall determine that interlocking or other safety appliances shall be put in, the railway company seeking to cross at grade shall be compelled to pay all costs of such appliances, together with the expense of putting it in and the future maintenance thereof.

Section 4. It shall be the duty of every railway company or person owning or operating any track involved in any such crossing to comply with and carry out fully, or unite with the others in doing so, any order of said commission made * * * such work to be completed within 90 days after such order is made unless the commission shall for good cause extend the time. When any such plant shall have been completed and made ready for use, it shall be the duty of the companies or persons concerned to notify the commission, whereupon said commission shall inspect or cause to be inspected the said complete plant in the same manner as is now provided in the act upon that subject, approved June 3, 1887. If, upon such inspection, the said plant is deemed to be well constructed and suitable and sufficient for the purpose, the commission shall issue a permit empowering the several companies or persons owning or operating the tracks involved herein to run such crossing without stopping, under such rules and regulations as may be in force, or may hereafter be adopted, by the said commission, any law in force upon the subject of stopping trains at railway crossings to the contrary notwithstanding.

Section 5. Any company, person or corporation refusing or neglecting to comply with any order made by said Railroad and Warehouse Commission in pursuance of this act, shall forfeit and pay a penalty of $200 for each week of such refusal or neglect.

Section 6. All expenses incurred in any proceeding under this act shall be paid by the railway companies concerned, in equal portions upon bills to be rendered by the Secretary of said commission.

Section 7. Every junction of two or more railroad tracks, whether the tracks joining each other are owned by different companies or by the same company, shall be taken and deemed to be a crossing within the meaning of this act; provided, that this section shall not apply to a switch, spur or side tracks.

It has been the policy of the present commission to discourage grade crossings, and whenever its authority was invoked it has not hesitated to prescribe over or under crossings except when physical and other conditions made it imprudent to do so. The act of May 27, 1889, however, gives the Railroad and Warehouse Commission jurisdiction over the location and construction of railway crossings in disputed cases only. In regard to protection of crossings, the act of June 2, 1891, gives the commission full power; it may of its own motion cite the companies interested and show cause why specified crossings should not be provided with interlocking devices.

Within the past year or two, there has been considerable discussion as to the commission's jurisdiction over electric or street railways. The present commission has held that it had this authority, and the commission under Gov. Altgeld's administration held that it had this authority when it passed on the case of the C. & A. R. R. Co. vs. the Alton Railway & Illuminating Company, in May, 1896. Chairman Neville, of the present commission, quoting in his opinion in the case of the C., M. & St. P. Ry. Co. vs. Alpheus P. Goddard and Alpheus J. Goddard and the Freeport General Electric Company, filed Dec. 11, 1901, says:

> We are of the opinion, and so hold, that for the purpose of this act (referring to Act of May 27, 1889), that any person, company or corporation desiring to cross another railway track with a railway track must cross it at such place and in such a way that it will not unnecessarily impede or endanger the travel of the railway company so crossed; and that it will not unnecessarily endanger the lives or property of the public, regardless of whether it is a railway corporation or an individual, the law applying to the railway itself, and not to the owners or operators.

There never was any doubt in the minds of the commission over the authority of electric or street railways outside of cities and villages, especially those incorporated under the general railroad act. During the past two or three years, the construction of electric railroads has gone forward at a tremendous pace, and this has brought on considerable discussion as to jurisdiction of the commission over crossings and protection in all cases. Attorney General Hamlin, in his opinion on the jurisdiction of the commission over crossings of steam and electric roads, says:

> In consideration of the provisions of the statutes above referred to and a review of the cases of our own courts, and regardless of the fact whether the act creating the commission covered all railway companies, I am of the opinion that the Act of 1889 made the commission an independent tribunal to act upon disputed future crossings of all companies, wherever located, for the protection of life and property, and the Act of 1891 enlarged the power of this independent tribunal to cover established crossings upon the application of either company thereto, and to cover established crossings, including crossings of two tracks of the same company, in all cases where danger existed. This tribunal is to act for the protection of life and property and to make that protection effective, its power covers all kinds of crossings,

whether situated in or outside of cities on private or public ground, and of any companies, for the words in the act are broad enough to embrace all these matters. The intent is broad enough to reach any dangerous crossing and the mischief to be remedied can only be remedied by thus construing these acts. Such being the case, and as this construction does not strain the words of the statute, but on the contrary, is within the usual meaning of the same, the power of the commission in my judgment, is well settled.

* * * * * * * * * * * * * *

In conclusion, one other argument in favor of the power of the commission is offered, and it is one which greatly adds to the position above taken. The Act of 1889 requires the commission, after the hearing, to decide "with due regard to the safety of life and property." The Act of 1891 requires the decision to be such a decision as "the public good requires." These words make the question of the power of the commission over crossings, a question involving a public interest, and where a public interest is involved, a statute is liberally construed so as to carry out the best interests of the public. If these statutes are to be liberally construed then they cover all crossings of all roads whenever the crossing is dangerous to life and property. If a public interest is involved, the jurisdiction of the commission is presumed unless the street railroads can make it appear that the legislature by affirmative words exempted them from the operation of the statutes, for in that case it would not be a question of extending the meaning of the statute by implication, but by limiting it by implication, and to place the limitation would require evidence of such an intent of the legislature. This principle plainly gives the Railroad and Warehouse Commission authority over all crossings for the purpose of "protecting life and property and compelling" the protection of the same.

Thus the Railroad and Warehouse Commission is invested with authority over the protection of all railway crossings, and is invested with authority over the construction of all grade railway crossings where the companies involved do not agree as to the place and manner of crossing. Railway crossings are dangerous, and therefore their number should be diminished rather than increased. With this end in view, it would be most desirable to have greater power conferred upon the commission through legislative enactment.

REPORT OF THE COMMITTEE ON MECHANICAL AND ELECTRICAL ENGINEERING.

Perhaps one of the most interesting works of the year has been the construction of the new power development on the Canadian side at Niagara Falls. About ten years ago, mechanical and electrical engineers were closely watching the installation at power house No. 1 of the Niagara Falls Power Co. This installation marked a decided improvement in hydro-electric installations, the most marked feature of which was the adoption of 5,000 H. P. electrical units. Since that time the original plant on the American side has been increased, and now has a total capacity of 105,000 H. P.

In the new Canadian Niagara Power Co.'s plants, the generating units are to be 10,000 electrical H. P. each. The wheel pit and power house have been planned for eleven of these units, making a total output capacity of 110,000 H. P. The generators are to be wound for three-phase currents, 12,000 volts, 25 cycle, at 250 revolutions per minute. The general plan of installation of this plant is very similar to that of the plant already in operation on the New York side. A second plant is also under construction on the Canadian side by the Ontario Power Co., which contemplates the development of 180,000 H. P. The water will be conducted from above the rapids in three 18 ft. conduits, and delivered to the power station built near the level of the lower river. The installation will consist of twin turbine wheels mounted on a horizontal shaft, and directly connected to 10,000 H. P. generators, which will operate at 187 revolutions per minute, and will deliver three-phase, 25 cycle, 12,000 volt current. A this company, the Electrical Development Co., of Ontario, has also begun work on the Canadian side. This installation will be quite similar to that of the first company mentioned, including 8,000 K. W. generators. It is contemplated to utilize a considerable portion of this power in Toronto, 90 miles distant, and in other nearer Canadian cities. Other important transmission plants have been installed on the Pacific Coast, and in the Rocky Mountain region.

The steam turbine which, at the beginning of the year attracted considerable attention, must still be regarded as in an experimental stage, and has not made the rapid progress which was anticipated. In a number of installations the actual results attained are still in question, and it is by no means demonstrated that this prime mover will seriously depose the high grade reciprocating engine, except possibly for certain classes of work in which its high speed makes it specially available.

On the other hand, the most important rival with which the steam engine has to contend, seems to be the gas engine when utilized with gas producer plants. During the last year a number of bituminous gas producer plants have been installed, which seem to give fairly satisfactory results. The saving in fuel resulting from these plants is very great, as the amount of coal consumed is only about 1¼ lbs. against 2 to 6 lbs. on the average combined boiler and engine plants. One of the points of principal importance in regard to these developments is that high efficiency design seems not to be confined to large powers, but economy is also possible even in units of 25 to 50 H. P. The cost of installation per H. P. is considerably greater for the gas producer and gas engine than in the case of the steam engine and boiler plant, but the saving resulting is so great that if it can be conclusively demonstrated that a satisfactory bituminous gas producer is available, a radical change in the type of future power installations must be expected.

The year past has also witnessed a considerable progress in the installation of interurban electric railways, and in the adoption of electricity as a motive power at the terminals of some of the leading railway systems. It is now generally conceded that the adoption of electric traction for terminals in large cities and for many branch lines is inevitable.

The year 1904 has been a year of important engineering meetings, among which the most noteworthy have been the International Electrical Congress, at St. Louis; the regular annual meeting of the National Electric Light Association, at Boston; and the Transmission Convention of the American Institute of Electrical Engineers, at Chicago. The meeting of the American Society of Mechanical Engineers in Chicago, and of the International Engineering Convention, at St. Louis (in which the Institution of Civil Engineers, of Great Britain), took an important part, are matters which were of more than ordinary interest.

DANIEL W. MEAD, T. W. SNOW, H. A. SLOCUM.

INDEXING PUBLICATIONS.

BY L. K. SHERMAN (MEMBER).

I have worked out a scheme for indexing publications. Each member receives a number of publications with the exchanges and our Report. In the course of time this makes quite a volume of literature, and forms a good technical library, but the difficulty is to find any particular paper or subject. I have solved that difficulty with a card index. In the reports that we get each year, the width of the index is just about the same. They could be very conveniently cut out and each title pasted on the cards such as come in an ordinary card index. I have aranged the index clippings, on the cards, by subjects. For instance, I start under A, "architecture, arches," etc. Under B, "bridges"; under C, "concrete," and so on. By this arrangement I can look up a subject very readily. For instance, I am looking up something on surveying. I look in the index under "Surveying," and find "Some peculiarities of government surveys," page 195, No. 3, Report of Michigan Engineers for 1904. Additions to the index can readily be made as we get other reports. Incidentally I might mention that these reports are rated at 50 cts. apiece. Thus the reports we receive annually are worth $5 to $6, which more than offsets what we have to pay for dues to this Society.

ENTERTAINMENTS AND EXCURSIONS.

In order to fittingly celebrate the 20th anniversary and to provide for the entertainment of visiting members, a special fund of $206 was raised by the Chicago members. After all expenses had been paid, a balance of $11.50 remained, which has been turned in to the treasury. The subscribers were as follows:

J. W. Alvord, H. H. Bremer, C. B. Burdick, W. P. Feeney,
S. N. Howard, W. D. Jones, F. C. Lang, R. Link,
D. W. Mead, C. Mendius, S. W. Miller, F. Norlin,
D. V. Purington, V. B. Roberts, F. C. Rossiter, E. Rudolph,
A. C. Schrader, E. F. Seelig, L. K. Sherman, W. S. Shields,
T. W. Snow, E. E. R. Tratman,

Chicago Bridge & Iron Co., Chicago Portland Cement Co., R. W. Hunt & Co., Keuffel & Esser Co., National Meter Co.

The entertainment included two excursions, a dinner, and a theater party.

EXCURSION TO CEMENT WORKS. On the afternoon of Jan. 19, a special car attached to a train on the Pennsylvania Lines and provided by the courtesy of the Cement Department of the Illinois Steel Co., took the party to Buffington, Ind. Here the company has recently established a large cement plant, having a daily capacity of 4,500 barrels of "Universal" Portland cement. This is the third plant operated by the Illinois Steel Co. It is one of the three largest Portland cement plants in the world, having sixteen 80-ft. kilns. The plant is driven entirely by electric motors, aggregating about 4,000 H. P., current being transmitted at 20,000 volts from the South Chicago works of the Illinois Steel Co., where waste blast-furnace gases are used for fuel. The mill buildings are of steel and concrete, but one of the features of the plant is an office and laboratory building constructed of stone made of "Universal" Portland cement, showing the possibilities of cement stone. The plant started in operation in December, 1904, and is considered a model modern cement plant.

EXCURSION TO THE CHICAGO TUNNELS. On the evening of Jan. 18, the party visited the tunnel system of the Illinois Telephone Construction Co., trains being provided by courtesy of Mr. George W. Jackson, Chief Engineer and General Manager. These tunnels were commenced in the latter part of the year 1901 by the Illinois Telephone Construction Company to carry telephone cables for the automatic telephone system. It was originally intended to lay the cables in conduits under the streets, but there were already telephone, telegraph, and all other kinds of conduits, sewers, gas mains, water mains, forming such a network in all the downtown district, that there was no room for another system of conduits. The engineer adopted the idea of avoiding everything of that kind by building a tunnel system 26 ft. below the streets. At that time there was no idea of using the tunnels for transportation. There are about 30 miles of tunnel 6x7½ ft. (horseshoe shape), and one mile of tunnel 12x14 ft. They run north, south, east and west and are built under all the streets in the downtown district. The tunnels were excavated mainly through solid clay, but the pneumatic process was used on account of occasional pockets of quicksand, etc. Steel centers were used for the concrete lining. It has now been decided to use these tunnels for the transportation of mail, newspapers, parcels, freight, coal, merchandise, etc., and for excavated material and building material. Branches will be run to the post offices, newspaper offices, warehouses, retail and wholesale stores, railway stations, etc. Extensions will also be run to the large railway yards and there will be a terminal and warehouse plant at Taylor and Beach Sts. on the west bank of the Chicago river. Here the freight will be sorted and distributed to the several railways. This will take many wagons and teams off the streets and relieve the congestion of traffic. Some of the great railways entering Chicago have organized a company to operate this transportation system. The tracks are 24 ins. gage, operated by electric locomotives partly on a trolley system and partly on a third-rail system, with a protected conductor rail between the track rails. This third rail is a track, and a cog wheel on the engine engages with it to take up the electricity.

CONSTITUTION AND BY-LAWS.

AS AMENDED AND ADOPTED AT THE FIFTEENTH ANNUAL MEETING HELD AT MOLINE, JANUARY, 1900.

CONSTITUTION.

ARTICLE I.—NAME.

This Association shall be called the Illinois Society of Engineers and Surveyors.

ARTICLE II.—OBJECTS.

The objects of this Society are the encouragement of professional improvement and of goodfellowship among its members, by meetings for the presentation and discussion of papers on scientific and other kindred topics, and the discussion of such other subjects as may be of interest to its members; the publication of such parts of its proceedings as may be deemed expedient; and the collection and preservation of books, maps, drawings, and other articles of value to the profession represented in its membership.

ARTICLE III.—MEMBERSHIP.

SEC. 1. Any engineer, architect, surveyor or person directly engaged in the designing, construction or maintenance of engineering or public works is eligible to membership; and any person who is engaged in the sale or manufacture of any supplies or materials used in engineering construction is eligible to associate membership.

SEC. 2. Each candidate for membership or associate membership shall make application in writing to the Executive Secretary on a printed form provided therefor by said Secretary. Such application shall state in writing the name, age, residence, present occupation and the nature and extent of professional service of the applicant; and must be endorsed by three members of the Society. The application shall be accompanied by a deposit of Three Dollars ($3.00) to be applied on account of the admission fee, if the applicant be elected, or refunded if he be not elected.

SEC. 3. Whenever any application for membership shall be received by the Secretary, a copy thereof shall be submitted to the members of the Executive Board within one month from date of the receipt of the same.

It shall be the duty of each member of the Executive Board within ten (10) days from the receipt of any application, to send his vote upon the electing of such person to membership to the Executive Secretary. PROVIDED, that any applications received within two (2) months immediately preceding any regular meeting of the Society shall be submitted by the Secretary of the Executive Board at its session immediately preceding such meeting of the Society. Four (4) affirmative votes shall elect such person to membership. The Executive Secretary shall include in his report to the Society the names and postoffice addresses of all persons elected.

SEC. 4. Any person may be elected an honorary member, by a unanimous ballot of all the members, not less than twenty in number, present at any regular meeting of the Society.

Honorary members may present papers and take part in all discussions, and shall be entitled to receive, on request made in writing each year, copies of the annual report of the proceedings of the Society, but they need pay no initiation fees nor dues, and shall have no vote.

SEC. 5. Any three members may present to the Executive Board charges in writing affecting the moral or professional character of any member, whereupon the said Board shall notify the member of such charges, and shall appoint a time and place at which the accusers and the accused may be heard. On an affirmative vote of at least four members of the Board, the charges shall be presented to the Society, as soon as it shall be in session, all parties being duly notified and having opportunity to be heard. On an affirmative vote of three-fourths or more of the members present, said affirmative vote being not less than eighteen in number, said member shall be expelled, and his name shall be struck from the roll; but no public notice of such proceedings shall be given.

SEC. 6. The annual assessment shall be due and payable in advance, and no publications of the Society shall be forwarded to any member till such annual dues be paid. Any member who shall refuse or neglect for one year after the annual meeting to pay any dues or assessment due from him, shall cease to be a member, and his name shall be struck from the roll. He may be reinstated on payment of the sum so due and of all further sums which would have been due from him had he remained a member up to the time of such reinstatement.

ARTICLE IV.—OFFICERS.

SEC. 1. The officers of this Society shall be a President, a Vice-President, an Executive Secretary-Treasurer and a Board of Trustees. The above named officers shall constitute the Executive Board, of which the President shall be ex-officio Chairman, and the Executive Secretary ex-officio Secretary. Two Trustees shall be elected annually and hold office for two years.

SEC. 2. All officers except the Executive Secretary-Treasurer shall be elected annually by ballot by the members, on the second day of the annual meeting, ,and shall hold office until their successors are elected and qualified. The Executive Secretary-Treasurer shall be elected annually by the Executive Board.

SEC. 3. The President, Vice-President, Executive Secretary-Treasurer, shall perform the duties usually pertaining to their several offices. The Executive Secretary-Treasurer shall be the custodian of all property of the Society, and shall deliver all such property to his successor, and shall make an annual report. He shall record the proceedings and discussions of the meetings, and shall prepare a copy of them for publication.

As Treasurer, he shall give bond with two approved sureties to such amount as may be required from time to time by the Executive Board, and his bond, when approved by said Board, shall be copied on the Journal of the Society, and be deposited with the President. He shall pay only such orders as have been signed by the President, Executive Secretary, and shall make an annual report of all receipts and expenditures, and shall deliver all the Society's books and money in his possession to his successor. The Executive Secretary, in addition to the duties usually pertaining to his office, shall be ex-officio Librarian of the Society, and as such shall collect and preserve all books, pamphlets, papers and documents belonging to the Society. The library of the Society shall be kept in some place central and convenient to access by railroad. He shall deliver all the property of the Society in his possession to his successor.

SEC. 4. The Executive Board shall audit the accounts of the Treasurer, and determine the assessment per member for the following year, immdiately before each annual meeting, and make annually a report to the Society. They shall arrange the program of exercises for each annual meeting, and shall have a general care over the affairs of the Society, and shall act for the Society in all general matters between the annual meetings. No moneys shall be expended without a vote of the Executive Board.

SEC. 5. There shall be appointed at each annual meeting the following standing committees of three members each: (*a*) Committee on Surveying;

(*b*) Committee on Roads and Pavements; (*c*) Committee on Railroads; (*d*) Committee on Water Works; (*e*) Committee on Drainage; (*f*) Committee on Sewers; (*g*) Committee on Exhibits; (*h*) Committee on Press. It shall be the duty of each committee to collate facts, figures and items of interest in their respective departments, and make at least one formal report to the Society at the annual meeting following their appointment. The chairman of each committee shall solicit, under the direction of the Executive Board, papers for the annual meeting, and advise with said Board in matters relating to the general subject of the committee's work.

ARTICLE V.—PUBLISHING ANNUAL REPORTS.

The Executive Board shall compile and publish the annual report of the transactions of the Society. They shall include in this report all items of general interest in the proceedings, and such other matters as may seem to them advisable.

ARTICLE VI.—COMPENSATION OF OFFICERS.

The Society may provide for the compensation of its officers for their services whenever deemed advisable.

ARTICLE VII.—AMENDMENTS.

All propositions for amendments of this Constitution shall be referred to the Executive Board, who shall report to the Society before final adjournment of the annual meeting, and such amendment shall be declared adopted by an affirmative vote of two-thirds of the members present, not less than fifteen members voting.

BY-LAWS.

SEC. 1. The annual meetings of this Society shall be in such place as shall be determined by this Society at each previous meeting, and at such time in January as shall be determined by the Executive Board. The Executive Board shall notify each member of the Society at least twenty days before the annual meeting.

SEC. 2. Ten members shall constitute a quorum for the transaction of business.

SEC. 3. The meetings of this Association shall be governed by "Roberts' Rules of Order."

SEC. 4. The order of business shall be fixed by the Executive Board.

SEC. 5. A record of all donations to the Society, whether in money, books, maps, models, or other articles of value, with names of the donors, shall be entered by the Executive Secretary in a book provided for that purpose.

SEC. 6. These By-Laws may be amended by a two-thirds vote of the members present at any annual meeting, not less than fifteen members voting.

DIRECTORY OF ENGINEERS AND SURVEYORS OF ILLINOIS.

(Those marked with a star [*] are members of the Illinois Society of Engineers and Surveyors.)

NOTE.—In Order that this List may be Kept Complete and Accurate, Members and Others are Requested to Examine it, and to Send Notice of any Additions or Corrections to the Secretary.

ABINGDON—J. W. Sussex.
ALBION—Joel Brown.
ALHAMBRA—*F. Oswald.
ALTO PASS—C. C. Freeman.
ALTON—Geo. Dickson.
  T. M. Long.
  E. E. Rutledge.
  H. C. Swift.
  E. B. Stakemiller, Eng. M. of W., Ill. Term. Ry.
  E. C. Welch, Eng. M. of W., C., P. & St. L. Ry.
AMBOY—*C. C. Jacobs.
ANCHOR—C. B. Stewart, U. S. Asst. Eng.
ATLANTA—Thos. Shore.
AURORA—*H. D. Hallett.
  Robert Horr.
  F. J. Allen, Eng. M. of W., C., B. & Q. Ry.
  H. B. Burgess, Supt. Bges., C., B. & Q. Ry.
  *G. C. Habermeyer.
  A. F. McClatchey, M. E.
  R. Nichols, C. & Min. Eng.
  M. G. Stolp.
  Myron Tarble, City Eng.
  *I. W. Troxel.
  *F. W. Von Oven.
  H. O. Westmark, M. E.
  M. H. Wickhorst, Eng. Tests, C., B. & Q. Ry.
  Geo. Wilder.
BATAVIA—E. K. Meredith.
  *T. W. Snow.
BEARDSTOWN—C. V. Brainard, U. S. Asst. Eng.
  C. H. Sexton.
  E. S. Slocumb.
BELLEVILLE—Louis Graner, City Eng.
  G. F. Hilgard.
  W. A. Reiss.
  A. Rosanko.
  E. S. Slocumb, A. Eng., I. C. Ry.
BELLMONT—Chas. Buchanan.
BELVIDERE—*W. A. Marean.
  M. J. Yaw.
BEMENT—*W. J. Day.
BENTON—Philip Lager, Co. Surv.
BIGGSVILLE—H. W. Stewart, Co. Surv.
BLOOMINGTON—*A. H. Bell.
  A. Brown, Cons. Eng.
  J. H. Burnham.
  W. P. Butler.
  W. B. Causey, Eng. M. of W., C. & A. Ry.
  Wm. Daves, Sig. Eng., C. & A. Ry.
  Elmer Folsom, Cy. Eng.
  C. E. Fuller, Supt. M. P., C. & A. Ry.
  R. B. Gray.
  *F. W. Ives.
  J. H. Leyonmarck, M. Eng., C. & A. Ry.
  *J. G. Melluish.
  Ira Merchant.
BLUE ISLAND—J. Link.
  P. R. Fletcher.
BRAIDWOOD—H. E. Boehn.
CAIRO—H. H. Hadsall, A. Eng., I. C. R. R.
  J. L. Lancaster, Res. Eng., M. & O. Ry.
  Wm. Thrupp.
CANTON—Harry Bond.
  *G. W. Chandler.
CARBONDALE—C. F. Sherman, A. Eng., I. C. R. R.
CARLINVILLE—Thomas Bacon.
  F. A. Chapman.
CARLYLE—Alex. Johnson.
CARMI—M. W. Spencer.
CARTERVILLE—A. J. Reef.
CARTHAGE—Geo. W. Page.
CENTRALIA—J. C. Sesser, C., B. & Q. Ry.
CHAMPAIGN—F. C. Amsbary, Manager Water Co.
  *I. O. Baker, Prof. C. E., U. of Ill.
  *O. L. Gearhart, City Engineer.

*C. W. Malcolm, Instr., U. of Ill.
*Jos. O'Brien, Co. Surv.
*L. G. Parker, Instruc., U. of Ill.
J. D. Wallace, Cons. Mech. Eng.
CHANDLERVILLE—H. S. Leeper.
CHARLESTON, Z. Green.
W. E. Millar.
CHATSWORTH—D. J. Sanford.
CHESTER—J. T. Douglas.
CHICAGO—(See Separate List).
CHILLICOTHE—G. F. Rees, Asst. Eng., A. T. & S. F. Ry.
CLINTON—David Richardson.
COLONA—J. B. Bassett, Jr. U. S. Eng.
COLLINSVILLE—R. L. Kneedler.
CRETE—A. S. Rosing.
CRYSTAL LAKE—J. H. Brink.
DAKOTA—W. H. Butterfield.
DANVILLE—Alex. Bowman.
E. S. Boudinot, Co. Surv.
Charles Cottingham, Cons. Eng.
*H. M. Ely.
A. S. Markley, Div. Eng., C. & E. I. Ry.
W. H. Martin.
R. Y. Maxon.
*D. H. Sawyer.
*G. B. Sidelinger.
DECATUR—Sullivan Burgess.
*A. B. Alexander.
G. A. Caldwell, Supt., Dec. Bge. Co.
H. J. Foale, Sig. Eng., Wabash Ry.
W. W. Greenland, A. Eng., Wabash Ry.
Geo. V. Loring, C. E. & Sur.
J. H. Powers, Chf. Drfts., Dec. Bge. Co.
E. Shelah, Eng. M. of Way, Wabash Ry.
J. M. Slater, A. Eng., Wabash Ry.
*W. M. Wood, Chf. Eng., Dec. Bge. Co.
DIXON—C. V. Kerch.
L. B. Neighbor.
C. F. Nesbit.
*A. M. Shaw.
T. J. Klossowski.
T. J. Wright, A. Eng., D. R. F. & S. W. El. Ry.
DWIGHT—R. P. Morgan, Cons. Eng.
EAST ALTON—F. W. Olin.
EAST ST. LOUIS—C. L. Baker.
W. H. Bennett, Chief Eng., St. L. & B. El. Ry.
J. F. Bower.
H. W. Cox, Chief Eng., Wiggins Ferry Co.
W. J. Crocker, Asst. City Eng., Co. Surv.
C. J. Ela, City Water Co.
E. F. Harper (Harper Bros.).
L. L. Harper (Harper Bros.).
E. G. Helm, Civ. & Con. Eng.
F. Hutchinson (Hutchinson & Jacob).
T. N. Jacob (Hutchinson & Jacob).
H. F. Juengst, City Water Co.
*J. F. Parr.
W. A. Thompson, Prin. Asst. Cy. Eng.
EDWARDSVILLE—J. Sheppard.
L. P. Yale, Winston & Co.
EFFINGHAM—J. B. Jones.
A. S. Moffit.
ELGIN—*W. W. Abell.
Hy. Dakin.
W. A. Gabriel.
A. L. Gifford.
A. M. Price, Con. M. E.
ETHERLY—E. W. Harms, M. M., Gales. & Gt. E. Ry.
EVANSTON—Robert Long.
*A. E. Barber.
U. S. Grant, Prof. N. W. Univ.
*John H. Moore, City Eng.
C. J. Morse.
FAIRFIELD—Adam Crouch.
FALL CREEK—C. H. Rankin.
FRANKFORT—C. W. Stilley, Co. Surv.
FREEPORT—T. R. Cummins, I. C. Ry.
L. F. Hayes, Min. Eng.
*G. W. Graham.
F. E. Josel.
O. T. Smith.
GALENA—J. B. Ginn.
W. H. Landers, Min. E.
J. S. Scott.
GALESBURG—F. J. Allen.
*F. M. Connolly, City Eng.
S. W. Curtis, Chief Eng., G. R. I. & Mon. El. Ry.
*John B. McAuley.
J. E. Murphy, E. M. of W., C., B. & Q. Ry.
A. L. Ritchey.
C. S. Ritchey, Co. Suprv.
J. C. Sheanan, Supt. Const., C., B. & Q. Ry.
GALVA—*L. Z. Jones.
GENESEO—M. G. Barnes, U. S. Asst. Eng.
*C. C. Martin, Co. Surv.
Kirk Martin.
C. M. Waters, Jr. U. S. Eng.

GENEVA—H. B. Alexander.
W. H. Pease.
GILLESPIE—F E. Stanley, Chief Eng., Mac. Co. Ry.
J. A. Giles.
M. E. Thomas, A. Eng., C. & N. W. Ry.
GLEN CARBON—S. M. Greenidge, Chf. Eng., Madison Coal Co.
GOLCONDA—W. T. McCormick.
C. H. Rauchfuss.
GREENFIELD——T. G. Clapp, Co. Surv.
GREENVIEW—James Bracken.
GREENVILLE—R. K. Dewey.
HARRISBURG—A. R. Longley, Chf. Eng., H. & So. Ry.
W. A. McHenry.
HARVEY—G. R. Brandon, M. E., Whiting Foundry Equip. Co.
T. D. Hobson.
HAVANA—J. R. Faulkner.
HINSDALE—G. W. Wilson.
HITT—L. S. Thorp.
HOMER—C. B. James, Chief Eng., Ch. & H. El. Ry.
HOOPESTON — M. C. Parker, Winston Bros. Co.
HUDSON—G. W. Gastman.
JACKSONVILLE—B. F. Bond, C., B. & Q. Ry.
C. W. Brown.
E. H. Crampton.
L. S. Olmsted, C. E.
J. L. Smetters.
M. D. Stewart, Supt. M. P., C. P. & St. L. Ry.
JERSEYVILLE—Walter Hansell.
A. W. Newton.
Edw. B. Shafer, Cy. Eng.
JOLIET—F. C. H. Arentz, Chf. Eng., Jol. Bge. & Iron Co.
G. W. Brown.
R. B. Campbell.
A. Comstock, C. E.
L. D. Fisher, M. E.
Geo. Jennings, Asst. Chf. Eng., E. J. & E. Ry.
G. F. Powers, Supt. Bges., C. L. S. & E. Ry.
W. M. McCartney, A. Eng., San. Dist.
A. Montzheimer, Chf. Eng., E. J. & E. Ry. and C. L. S. & E. Ry.
*R. E. Orr, C. E. and Surv.
*J. H. Sabin, E. J. & E. Ry.
*H. A. Stevens.
A. H. Westfall, E .J. & E. Ry.
KANKAKEE—*R. D. Gregg, Cy. Eng.
W. R. Sanborn, I. I. & I. Ry.
G. P. Smith, E. M. of W., I. I. & I. Ry.
W. H. Woodruff.
KEWANEE—J. C. Banister.
E. S. Galusha, City Eng.
*J. E. Kemp.
KILBOURNE—J. E. Barnes.
KIRKWOOD—M. F. Davidson.
LACON—*G. F. Wightman.
LA GRANGE—W. B. Ewing.
LA HARPE—S. A. Stern.
LA SALLE—J. A. Ede, Cons. Min. Eng.
J. W. Hegeler, Min. Eng.
F. W. Matthiesson.
A. H. Neureuther.
*C. H. Nicolet, M. & H. Zinc Co.
E. J. Noonan.
C. N. Rickard, City Eng.
LAKE CREEK—J. S. Perrine, Co. Sr.
LAKE FOREST—Jas. Anderson Jr.
Thomas Byrne.
LAWRENCEVILLE—H. G. Buchanan.
LEAF RIVER—J. B. Bertolet.
LINCOLN—D. L. Braucher, Co. Sur.
T. S. Davy.
*L. J. Sims.
John Zeter.
LITCHFIELD—Wm. Bates.
A. G. Kleinbeck.
LOW POINT—*G. M. Clark.
McNABB—*John McNabb.
MACOMB—*C. Holmes.
C. G. Holmes, Surv.
J. F. Shannon, Surv.
MADISON—R. E. Griswold, Supt., Barber As. Pav. Co.
MANSFIELD—R. S. Carberry.
MANTENO—*J. F. Schmeltzer.
MARSEILLES—*A. F. Nichol.
Eben J. Ward.
MARION—B. S. Craine, Chf. Eng., Coal Belt Ry.
W. P. Hoppin.
Lewis Pulley.
MARTINSVILLE—C. S. Hawkins, Co. Surv.
John F. Lafferty, Surv.
MATTOON—W. M. Doane, Supt. Cons., C. C. C. & St. L. Ry.
H. W. Clark, Supt., Mattoon Water Co.
Claud L. James, Drain. Eng.
A. C. Loomis.
W. E. Miller.
L. S. Rose, Eng. M. W., C. C. C. & St. L. Ry.
L. S. Stubbins, Surv.

*J. Withington.
MENDOTA—W. F. Whitmore.
METROPOLIS CITY—C. A. Geltner.
MOLINE—C. L. Crabbs.
H. Ainsworth.
*D. Gordon.
M. A. Gould.
W. P. Hunt.
R. W. Jones.
*H. G. Paddock, City Eng.
O. J. Root.
W. Wright, Supt. M. P., C., R. I. & P. Ry.
MOMENCE—*J. L. Clark.
MONMOUTH—*A. W. Gates.
*Thomas McClanahan.
C. E. Nash, C. E.
MORGAN PARK—E. Gray.
MORRIS—John Burmeister.
MOUND CITY—J. B. Mathias.
M. N. Moyers.
MOUNT CARMEL—R. A. Buchanan.
G. C. Harvey.
R. H. Moore, Eng. M. of W., C. C. C. & St. L. Ry.
MOUNT CARROLL—L. S. Thorp.
W. T. Pierce, C. E.
MOUNT PULASKI—J. W. Ewing, Surv. and Drain. Eng.
MOUNT VERNON—Isaac A. Smith.
W. T. Williams.
MURPHYSBORO—W. F. Hughes, Co. Surv.
J. E. Craine.
Geo. Kennedy, Jr., City Eng.
NATRONA—B. Buxton.
NEWTON—Wm. Kilgore.
NORMAL—G. B. Herrington.
OAK PARK—*R. A. Carpenter, Eng. & Com. P. Wks.
B. C. Brandstadt, Asst. Eng.
OLNEY—Bryant Higgins.
Frank Nuding.
ONEIDA—M. G. Voris.
OQUAWAKA—E. L. Moffett.
OREGON—Thomas Jakeman.
OTTAWA—Wm. Caton, Asst. Eng., Ill. Val. Trac. Co.
W. A. Dunaway.
C. F. Wilson, City Eng.
PARIS—W. T. Blackburn.
G. V. Dole.
PAW PAW—Wm. McMahon.
PAXTON—C. F. Helman, City Eng.
*J. T. Stewart.
PEKIN—D. H. Jansen, City Eng.
*H. Bloompot.
John A. Seibert, Co. Surv.
R. O. Van Duser.
PELLONIA—T. A. Giltner.
PEORIA—Daniel Allen.
*C. G. Anderson.
H. E. Beasley, City Eng.
Clay Belsley, M. E.
J. H. Best, Jr. U. S. Eng.
*O. F. Dubuis.
*C. H. Dunn.
*W. C. Evans.
Henry Fox, U. S. Asst. Eng.
*J. A. Harman.
C. C. Jett, Bradley P. Ins.
A. Lagron.
*D. H. Maury.
David Roberts, Asst. Cy. Eng.
*A. D. Thompson.
J. W. Woermann, U. S. Asst. Eng.
PERU—T. F. Noon, Ill. Zinc Co .
PETERSBURG—John Tice, Co. Surv.
Hobart Hamilton, C. E. and Dep. Co. Surv.
PITTSFIELD—M. Y. Smith, Co. Surv.
PLANO—I. Smith, Co. Surv.
PLAINFIELD—F. G. See, M. M., Jol. P. & Aut. El. Ry.
POLO—*J. A. Davison.
*A. D. Waterbury.
PONTIAC—*P. C. Knight.
PRINCETON—R. Hodgman.
PULLMAN—A. Twyman, Eng. Cons. Dept., Pullman Co.
QUINCY—E. H. Arnold, Q. & W. Ill. El. Ry.
*W. P. Bushnell.
Enoch R. Chatton.
W. H. DeGroot.
*F. L. Hancock, City Eng.
Thomas Hill, M. E.
Edward Prince, Cons. Eng.
Jesse M. Worthen, Civ. & Min. Eng.
RAMSEY—C. Holman, Sur.
ROCHELLE—Howard Smith.
ROCKFORD—M. Baldwin, Co. Sur.
L. A. Bostwick.
S. B. Hand, Asst. City Eng.
*C. C. Lakin.
*Edwin Main, City Eng.
A. E. Rutledge, C. E.
*C. C. Stowell.
F. L. Tissandier, Co. Surv.
ROCK ISLAND—Wm. A. Darling.
*W. H. Kimball.
J. L. Lusk, Major U. S. Engrs.
A. L. Richards, U. S. Asst. Eng.
Wallace Treichler, City Eng.

RUSHVILLE—Howard F. Dyson, City Eng.
Jeremiah Stumm, Co. Surv.
ST. DAVID—*J. C. Quade.
SALEM—L. S. Meredith.
SAVANNA—James Hunt.
SHABBONA GROVE—*J. E. Shepardson.
SHEFFIELD—H. E. Reeves, Jr. U. S. Eng.
SHELBYVILLE—C. E. Chester, Co. Surv. & Man. of W. W.
L. E. Fish, Eng. and Surv.
C. S. Woodward.
SIDELL—*W H. Herron.
SPARTA—L. R. Moran, Eng. M. of W., Ill. So. Ry.
SPRINGFIELD—*L. P. Atwood.
J. B. Barnes, Supt. M. P., Wab. Ry.
*S. A. Bullard.
Nicholas DuBois.
*Allen Enos.
*Z. A. Enos.
*F. G. Ewald.
F. H. Hamilton.
A. Hay, Eng. of Park Dist.
E. M. Merryweather, E. M. of W., Wabash Ry.
*D. H. Sawyer.
*W. H. Tarrant.
SPRING VALLEY—*Leo. Gluck.
M. S. Peltier.
STERLING—M. J. Barnes, U. S. Asst. Eng.
*F. W. Honens, Jr. U. S. Eng.
A. O. Rowse, Jr. U. S. Eng.
L. L. Wheeler, U. S. Asst. Eng.
STEWARD—E. H. Barrett, Supt Const., C., M. & St. P. Ry.
B. L. Henning, Eng. Inlet Swamp Dr. Dist.
STILLMAN VALLEY—A. Johnson.
STREATOR—W. B. Benson.
*D. E. Huggans.
F. T. Rolph, C. E.
SYCAMORE—S. T. Armsrong, Co. Surv.
*W. M. Hay.
A. B. Russell, Cy. Eng.
TAYLORVILLE—*J. W. Dappert.
J. S. Michels.
THEBES—Martin Brown.
TOLUCA—M. Fox, Min. Eng.
W. J. Hoscheidt, Chief Eng. T. M. & N. Ry.
TREMONT—Josiah M. Sawyer.
TUSCOLA—H. C. Niles.
URBANA—L. P. Breckenridge, Prof. M. E., U. of Ill.
Morgan Brooks, Prof. El. E., U. of Ill.
*F. G. Frink.
G. A. Goodenough, U. of Ill.
*N. C. Ricker, Dean of Eng., U. of Ill.
D. T. Randall, U. of Ill.
J. W. Royer, U. of Ill.
*R. H. Slocum, U. of Ill.
*A. N. Talbot, U. of Ill.
*L. A. Waterbury, U. of Ill.
VANDALIA—*P. E. Fletcher.
James H. Johnson.
VILLA GROVE—R. McCalman, Div. Eng., C. & E. I. Ry.
VIOLA—Wm. McLaughlin.
WARRENVILLE—Geo. Galusha.
WAUKEGAN—H. L. Bowen.
*M. R. Miller.
*C. P. Westerfield.
WESTERN SPRINGS—Edgar Williams.
WEST McHENRY—Geo. Gage.
WHEATON—*G. I. Herrick.
C. Jones, Chief Eng., A. E. & C. El. Ry.
*C. A. Prout.
*E. E. R. Tratman.
J. S. Vallette.
*A. L. Webster.
WINNETKA—C. W. Coman.
L. M. Johnson.
*F. A. Windes.
WYANET—Jos. Wright, Jr. U. S. Eng.
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WOODSTOCK—R. O. Smith.
ZIEGLER—C. C. Whittier, Ziegler Coal Co.
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H. R. Abbott	Sanitary District
W. L. Abbott	Chief Eng., Chicago Edison Co.
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John P. Ball	Res. Eng., C. & E. Ill. Ry.
W. D. Ball	Cons. Eng., Merchants Loan & Trust Bldg.
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ANNUAL MEETING, 1906

The Twenty-first Annual Meeting will be held at ***Rockford, Illinois,*** on January 17, 18 and 19, 1906.

A meeting of the Executive Committee will be held in October to make the preliminary arrangements.

ADVERTISEMENTS

A large and varied list of Advertisements accompanies this Report, and members are asked to look these over, as being interesting and instructive as well as commercially useful.

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See Classified List of Advertisements, page 205.

295345

Illinois Society of Engineers and Surveyors

SIXTEENTH ANNUAL REPORT

1901

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VIIA

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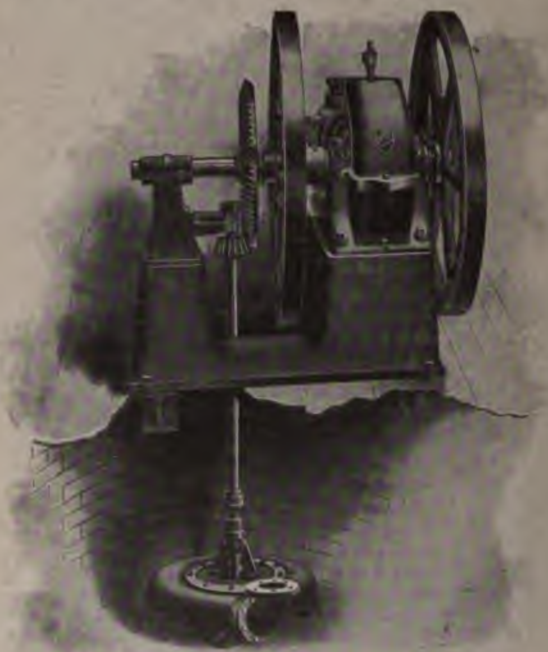

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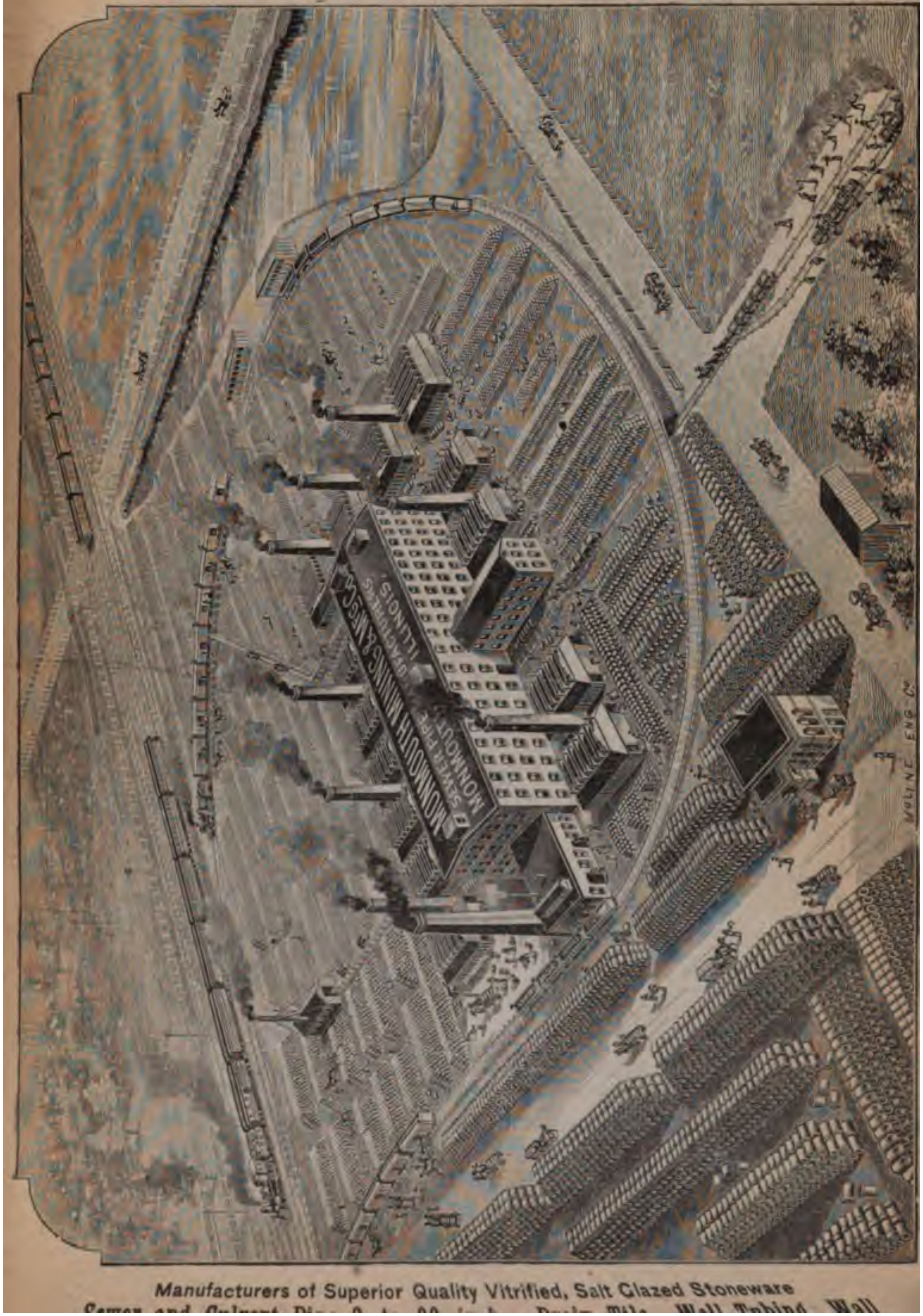

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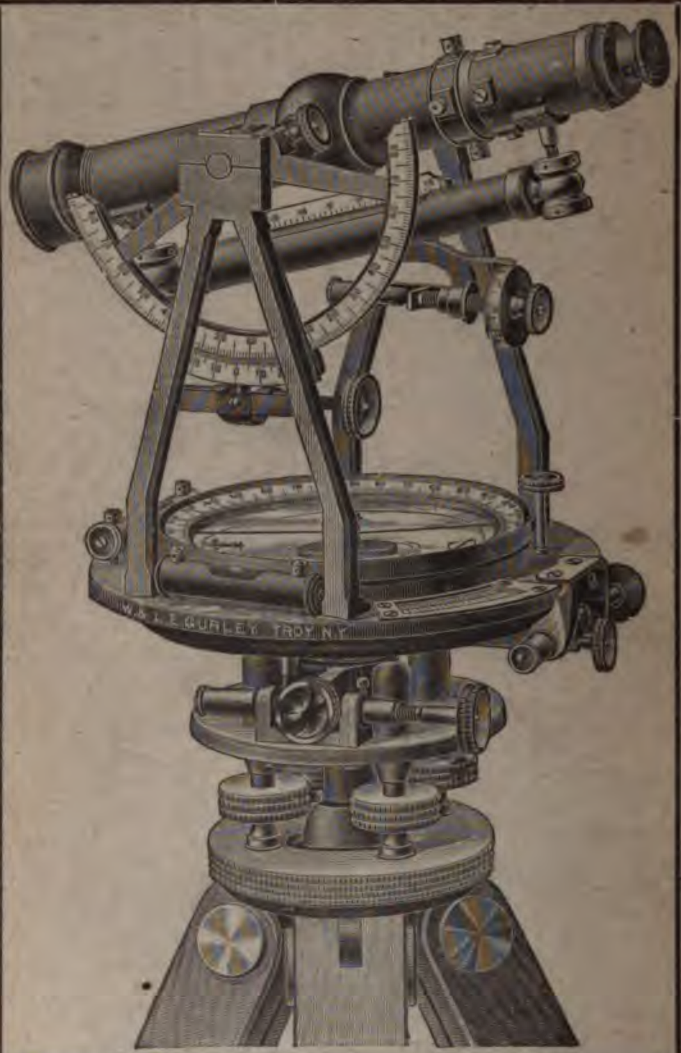
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WATER SOFTENING PLANT

Fig.3

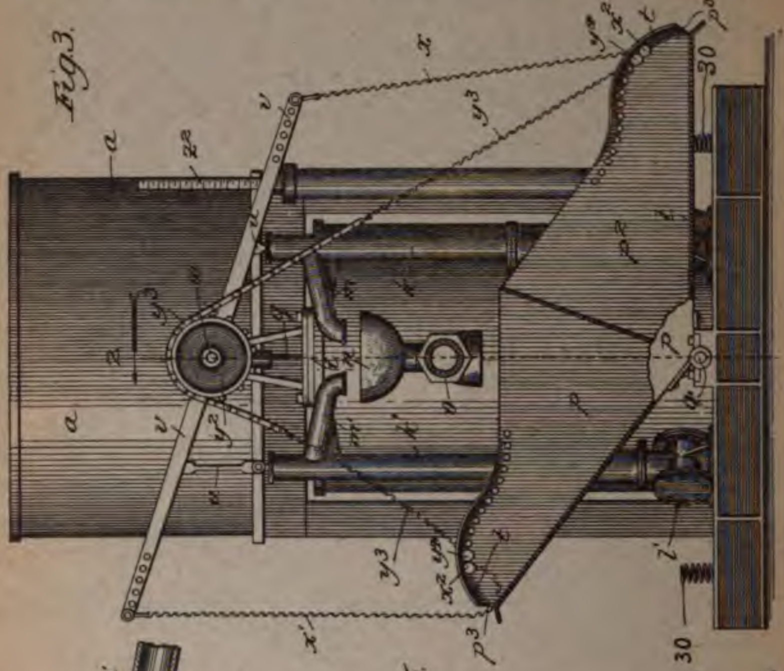

Fig.5

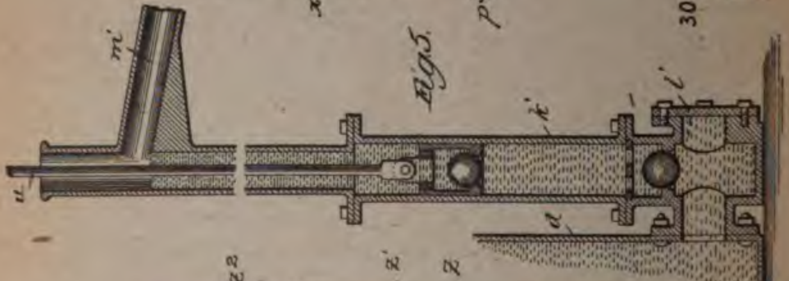

Fig.4

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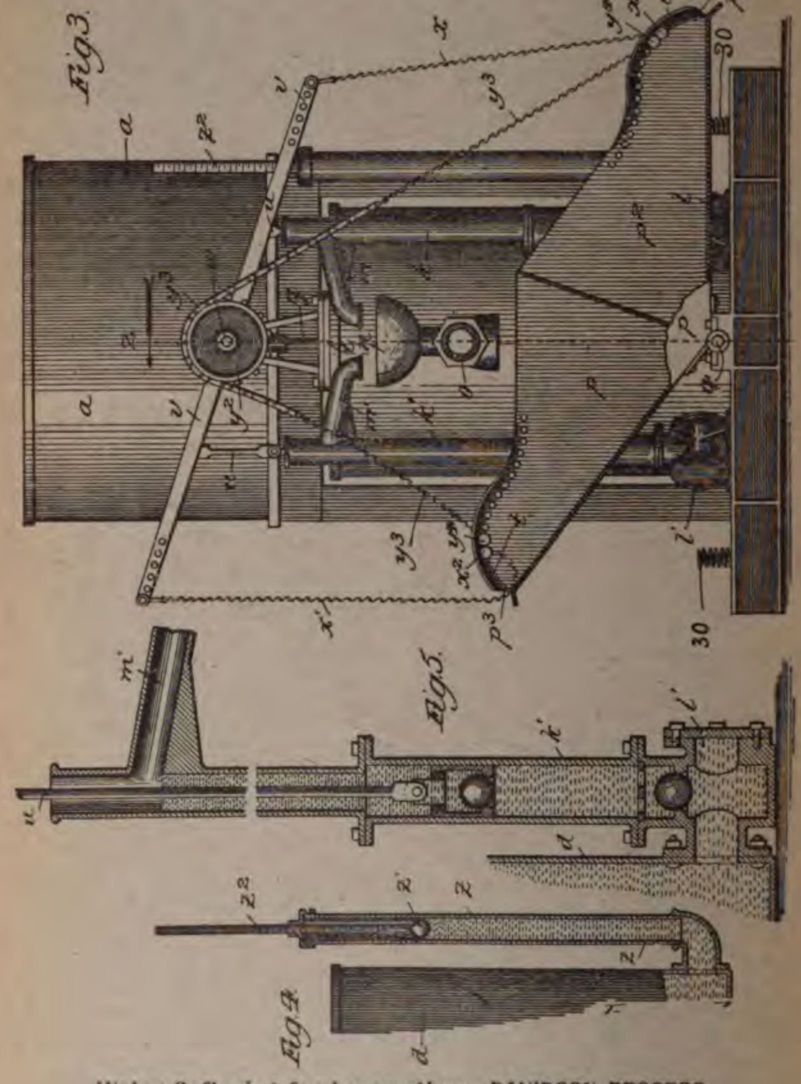

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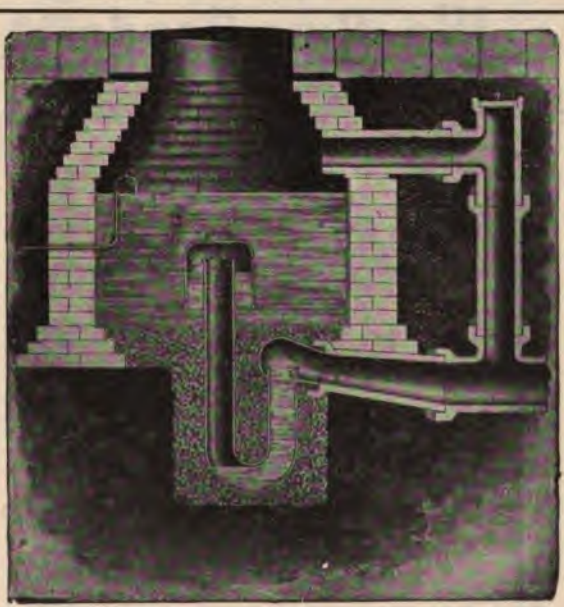

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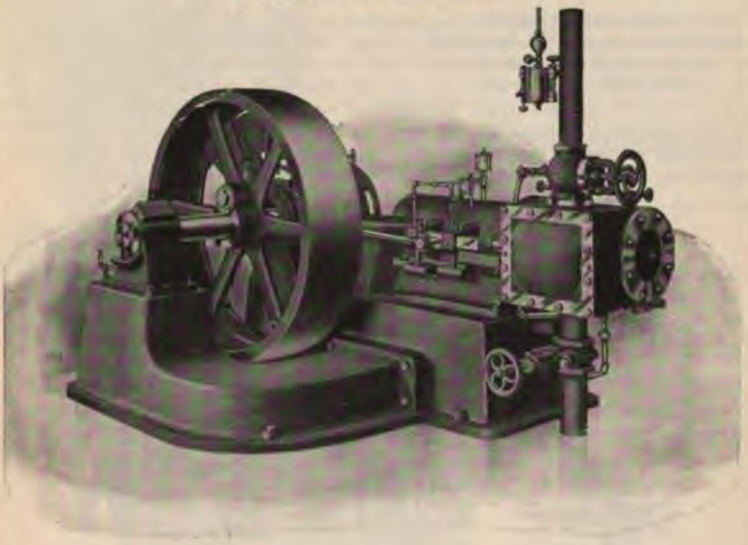

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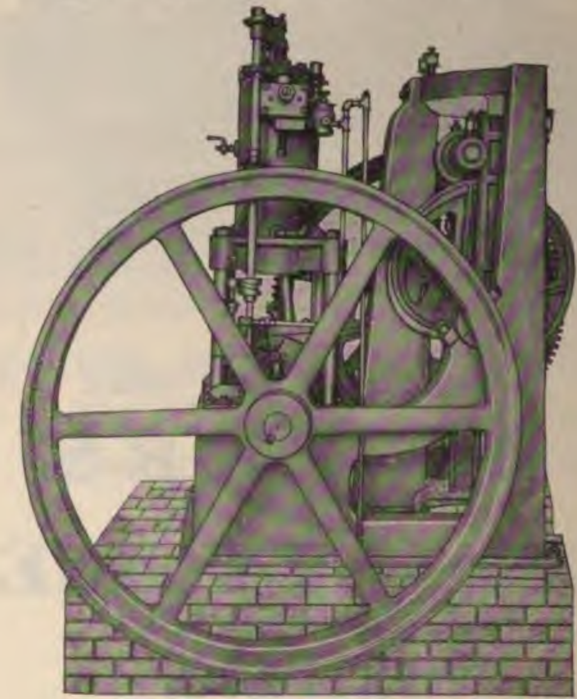

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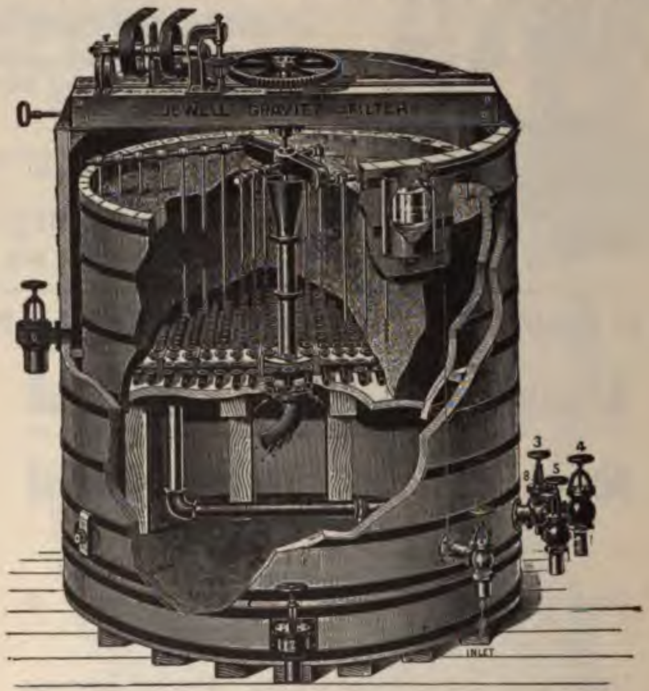

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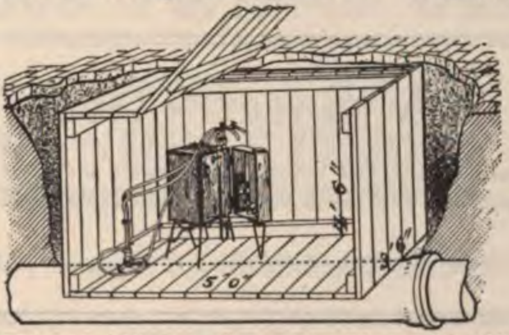

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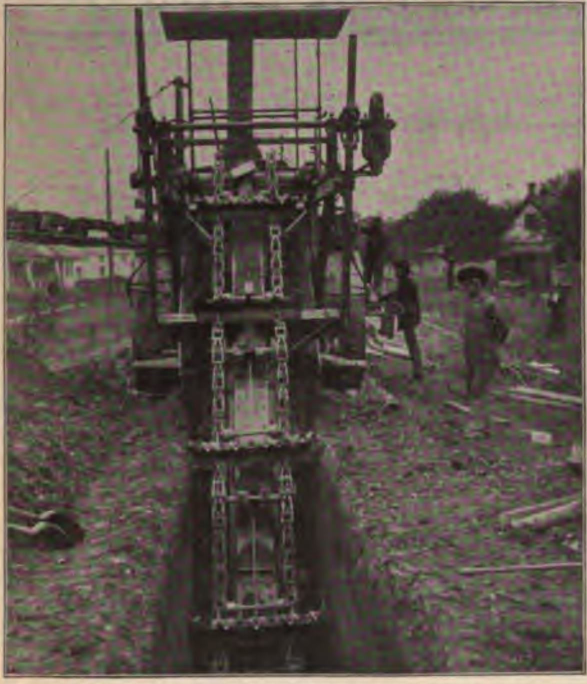

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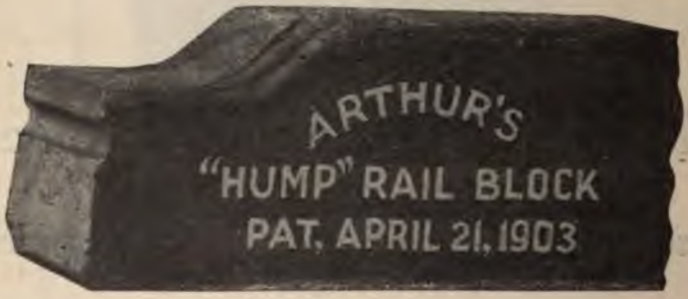

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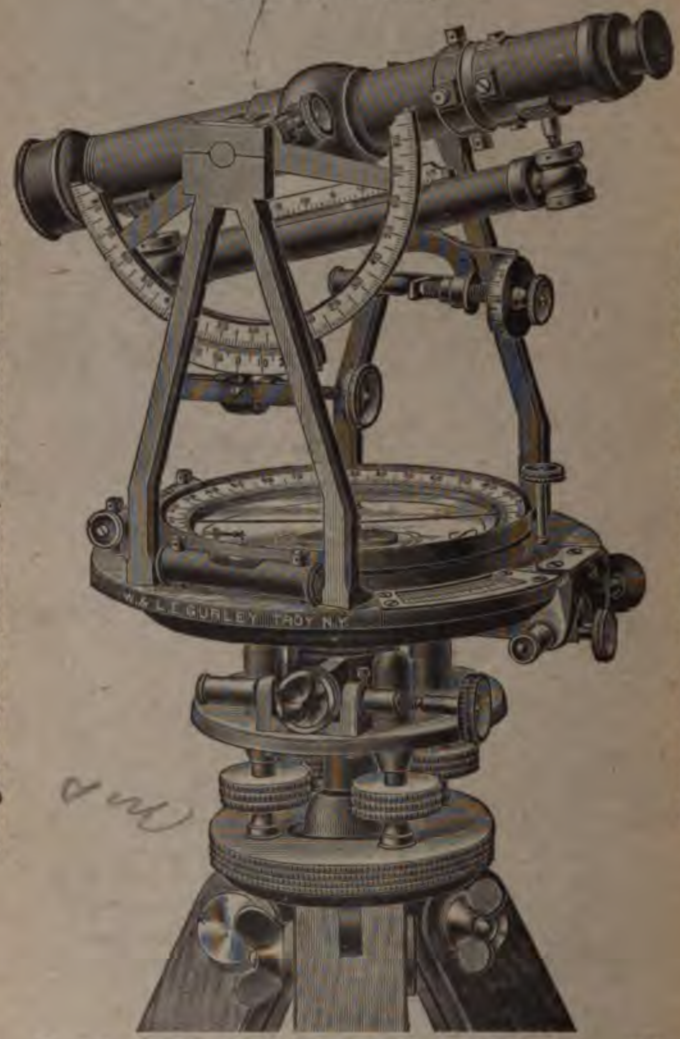
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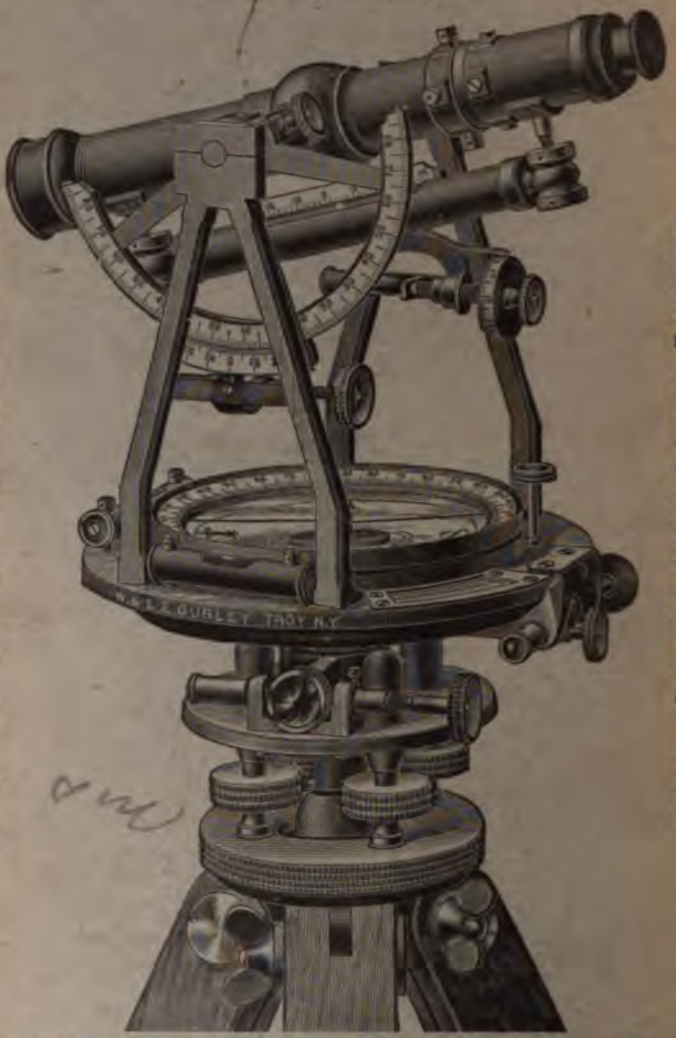
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